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HUMAN FACTORS AND TRAINING EVALUATION OF THE IMPROVED TOW VEHICLE (ITV) DURING OT/DT III

Seward Smith, Thomas J. Thompson, and Alexander Nicolini

ARI FIELD UNIT AT FORT BENNING, GEORGIA

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information from test soldiers, personnel playing the role of the threat force and from project personnel.

The ITV was judged to be good in concept but to be lacking in durability and reliability throughout OT/DT III. It was also judged to have problems keeping up with other vehicles and to be somewhat slow getting into or out of action. Boresighting was a problem. Command and control problems were evident at the squad leader's station. Many recommendations to improve the vehicle and training to operate it were made. Many of these recommendations have already been heeded and major improvements have been implemented.

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**HUMAN FACTORS AND TRAINING EVALUATION
OF THE IMPROVED TOW VEHICLE (ITV)
DURING OT/DT III**

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FOREWORD

This research was conducted by the Army Research Institute - Fort Benning Field Unit as Technical Advisory Service to the United States Army Infantry Center. The research topic also directly related to two ongoing research tasks: Systems Development and Training Research; and Development of Cost-effective Collective Training in Infantry.

This research effort represents a minor departure from the Institute's usual involvement with developing systems. This is because: (1) the research was requested directly by the TRADOC System Manager for the Improved TOW Vehicle (TSM-ITV); and (2) the research involved detailed interaction, coordination, and cooperative effort with the Operational Test and Evaluation Agency (OTEA) for Operational Test III and with the Army Material Systems Analysis Agency (AMSA), and the Test and Evaluation Command (TECOM) for Developmental Test III. The Institute staff was requested to provide both independent evaluation and data integration between the test situations. This report indicates the highly successful nature of this cooperative venture into human factors and training research on developing systems.

The research was conducted by ARI staff at the Fort Benning Field Unit with the consultant support of Dr. W. C. Middleton, provided by Litton-Mellonics under contract DAHC-19-77-C-0011. The project was performed as part of the Army's RDT&E program in the behavioral sciences under FY 77-78 Project 2Q763743A773. It was directly responsive to the needs of the Infantry Center and of Training and Doctrine Command (TRADOC).

Joseph Zeldner

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HUMAN FACTORS AND TRAINING EVALUATION OF THE IMPROVED TOW VEHICLE
(ITV) DURING OT/DT III

BRIEF

Requirement:

The TRADOC System manager for the Improved TOW Vehicle (TSM-ITV) requested ARI assistance in assessing human factors and training problems during the operational and developmental testing (OT/DT III) of the ITV, to identify any problems that should be corrected either by the ITV system manufacturer or by the training community prior to purchase and system adoption.

Procedure:

Data were gathered at the two test sites using questionnaires, interviews, and observations of training and crew operations throughout the entire OT/DT III test cycles. Data were collected from the ITV test crews, from persons acting as threat force crew members, and from project personnel. Data collection consisted of detailed human factors questionnaires, ratings of the ITV, quality of design and redesign requirements for the ITV, and in depth questionnaire and interview examinations of all ITV training.

Findings:

The ITV was judged good in concept but lacking in durability and reliability during OT/DT III. Squad leaders gave overall ratings of the ITV that fell between "Poor" and "Very Poor." Problem areas were vulnerability, ability of the ITV to keep up with other vehicles, and boresighting the launcher system. Overall, several safety problems were cited. Serious command and control problems were highlighted due to poor visibility from the commander's station.

Training developed at the Armor and Infantry Schools appeared adequate for the test requirements. No negative transfer of training appeared between ground mounted TOW and ITV tracking systems. Skill loss on ITV performance appears to be greater than for TOW and gunners suggested ITV tracking practice on a weekly basis.

Several recommendations for ITV improvements were made for each crew position and for the vehicle in general.

Utilization of Findings:

As a result of these efforts several changes were made in the ITV during redesign. ARI has also assisted the Operational Test and Evaluation Agency (OTEA) in the Follow-on Evaluation of the vehicle.

HUMAN FACTORS AND TRAINING ASSESSMENT OF THE IMPROVED TOW VEHICLE (ITV)
DURING OT/DT III

<u>CONTENTS</u>	<u>PAGE</u>
INTRODUCTION AND SUMMARY	1
Procedure	1
Results	2
Conclusions and Recommendations	6
RESEARCH PLAN	7
Test Instruments	7
Questionnaires	7
Interviews	8
Observations	9
Other Data	9
Subjects	9
RESULTS	10
Data Considerations	10
Overall ITV Ratings	11
Squad Leaders and Gunners	11
Threat Force	11
Human Factors Questionnaire	14
All OT III Crew Members	14
Squad Leaders	18
Gunners	23
Drivers	23
Loaders	33
Quality of Design/Redesign Requirements Questionnaire	36
Squad Leader's Station	36
Gunner's Station	36
Vehicle Limitations	36
Secondary Armament	36
Space and Storage	41
Interview Summary	42
Squad Leader Comments	42
Gunner Comments	43
Driver Comments	46
Loader/Observer Comments	47

Training	48
Key Training Issues	48
Quality of Instruction	49
Gunner Qualifications	50
Program Changes	50
Evasive Target Simulator (ETS)	51
 RECOMMENDATIONS	 53
The Vehicle in General	53
Reliability/Ruggedness	53
Keeping Up and Go Where Other Vehicles Can Go	53
Speed Into and Out of Action	53
Less Frequent Boresighting	53
Night Sight Controls	53
Command and Control - CVD	53
Visibility for Scouts	54
Backup Power	54
Squad Leader's Station	54
Gunner's Station	54
Driver's Station	56
Loader's and Observer's Area	56
Miscellaneous	57
 APPENDICES	
Appendix A	58
ITV Human Factors Questionnaire	58
ITV Ratings	81
Quality of Design/Redesign Requirements Questionnaire	84
Training Questionnaires	91
Phase A, Post-training	91
Phase B, Post-training	104
Post OT III Training Evaluation	115
Bias Questionnaire	122
Appendix B, Memo on Reversal of ITV Commander's Position	125
Appendix C, Memo of the Evasive Target Simulator	129
Appendix D, ITV Training Evaluation and Recommendations	135
 TABLES	
Table 1. Summary of Mean ITV Ratings for Different Groupings of Respondents	12
2. Summary of Mean Human Factors Questionnaire General Questions for Different Group of Respondents	15

3. Summary of Mean Answers to Squad Leader Questions from the Human Factors Questionnaire	19
4. Summary of Mean Responses to the Gunner's Items of the Human Factors Questionnaire	24
5. Summary of Mean Responses to the Driver's Items of the Human Factors Questionnaire	29
6. Summary of Mean Responses to Loader's Items for the Human Factors Questionnaire	34
7. Summary of Means Ratings of Quality of Design of the ITV System for Different Groupings of Respondents	37
8. Infantry OT III, Phase A and Phase B ITV Qualification Scores	51
9. Cavalry and Infantry Post Training ITV Qualification Scores (M70)	52

INTRODUCTION AND SUMMARY

In July 1977 the TRADOC System Manager for the Improved TOW Vehicle (TSM-ITV) requested assistance from the Army Research Institute (ARI) to assess human factors and training during final ITV operational and developmental testing (OT/DT III). The ARI Field Unit at Fort Benning, Georgia accepted the responsibility as a TAS effort.

Key purposes of the ARI involvement were: to provide greater than usual integration of human factors and training data from the two test programs (DT and OT), and to take full advantage of the presumed last chance for solid user feedback prior to a decision to buy and field the ITV. The major objectives of the effort were:

- To identify potential human factors and training difficulties/problems in employment of the ITV system,
- To provide quantifiable means for ITV users and test personnel to reveal problems and recommend solutions,
- To integrate all available data and provide TSM-ITV with a human factors and training evaluation of the ITV system, and
- To evaluate the suitability of the ITVETS (Evasive Target Simulator) as an ITV training device.

PROCEDURE

Together with resident contractor (Litton-Mellonics) personnel, ARI-Benning gathered information at both test sites using questionnaires, interviews, and observations of training and crew operation. Questionnaire materials evolved through the lifecycle of the OT/DT III with the increased understanding of ITV problems and with test personnel inputs. The following major questionnaires were developed:

- ITV Human Factors Questionnaire,
- ITV Ratings,
- Quality of Design/Redesign Requirements Questionnaire, and
- Training Questionnaires.

These instruments dealt with general ITV system and crew member specific human factors problems, overview ITV ratings, comprehensive training examination, and potential issues for ITV system redesign and engineering improvements.

The persons who contributed data to the results reported here were:

- Test soldiers from DT III, TOW/ITV gunners (N = 12),
- Test soldiers from OT III
 - Mechanized Infantry crew members (N = 24)
 - Armored Cavalry crew members (N = 10),
- Threat Force Personnel (N = 14), and
- Project personnel (e.g., Controllers, Data Collectors, Mechanics, N = 44).

The ITV testing was carried out in two phases (A and B) with a 3½ month gap between for vehicle modifications. Human factors and training data were collected at the end of Phase A (November 1977) and Phase B (March 1978).

Complete data were gathered from most of the ITV user soldiers. Other persons were given those questionnaire materials applicable to their activities and/or knowledge.

RESULTS

The ITV was judged to be good in concept but to be lacking in durability and reliability throughout OT/DT III. Since completion of the testing (March 1978) many of the soldiers' criticisms and recommendations contained in this report have been or are being corrected by the manufacturer. Presumably many of the "fixes" will remove OT/DT III problems, but until tested the ITV modifications can only be assumed to be successful. This report details the soldiers' views as of the end of OT III (March 1978), and hence does not deal with any equipment modifications accomplished since that time.

a. Overall ITV Ratings

Squad leaders, the most knowledgeable group about the vehicle, gave an overall average rating of the ITV for combat use that fell midway between "Poor" and "Very Poor". They rated 17 of 29 items in the range between "Fair" and "Very Poor", indicating that they found

considerable fault with the vehicle. Only in the areas of ability to track and hit targets and weapons safety did the ratings fall in the "Good" range. Ratings that fall in the "Poor" range or worse obviously deserve careful attention from designers and decision makers. Squad leaders were concerned about ability to keep the ITV operational (e.g., ruggedness, reliability, vulnerability, keeping the missile system boresighted). They were also concerned about the ITV's ability to keep up with and go where other combined force vehicles could go (climbing, etc.).

In sum, at the completion of OT III ITV crew members were seriously concerned that the ITV was not ready to be fielded.

Another group whose opinions merit examination is the threat force. These tank commanders served as opponents of the ITV during the various field exercises throughout OT III. Among those areas they felt competent to rate, 17 of 20 were rated "Fair" or worse. From questionnaire comments and in discussions with threat force personnel, the view emerged that the ITV in its initial defilade defensive position would be effective, but when it had to move on the battlefield it would be vulnerable. A major reason was how long it takes the ITV to fire a missile after halting from movement, but the open terrain of the test site may also have influenced their opinion.

b. Human Factors Questionnaire

For each item in this questionnaire crew members indicated how much of a problem (from none to serious) the item had been. Key samples identified as problems in the moderate to serious range are cited below.

Several safety problems that are typical of cramped armored vehicles were highlighted: objects sticking out, clothing and web gear snagging, and amount of crash padding. The rotating bottom plate of the turret was seen as dangerous to feet and because objects can get underneath.

The loading plan of the ITV was criticized. Equipment is subject to damage because of inadequate storage and because of loose items on the floor. Crew members were particularly bothered by having to carry personal gear externally. Delay getting at their personal weapons where stored was also seen as a problem.

Squad leaders noted problems with the commander's viewing device (CVD) and with the commander's station generally. The infantry track commander's station utilized a periscope (the CVD) which was not employed by the cavalry. The infantry squad leaders found considerable fault with the device. The station affords no view of the battlefield except through the CVD. Seeing well in the daytime is difficult, at night worse (because of no night vision device capability) and on the move nearly impossible. Specific problems included: difficulty seeing because of obstructions,

mud, etc. on lenses, too little magnification, narrow field of view, difficulty estimating range, trouble identifying and prioritizing targets, and covering the area of responsibility. For the infantry it was difficult to carry out command and control functions (with crew or other vehicles), and to navigate (either with the CVD or from the loader's hatch). All squad leaders said there were serious problems due to too little space in the squad leader's station and because of difficulty reaching their personal weapons where stored.

Gunners also indicated several problem areas. With the hatch open they had clear vision to the front, but the launcher obstructed vision to the sides and rear. When buttoned up range estimation through the sights was difficult. In addition, dust, rain, mud and debris on lenses, unclear optics and fogging of the image transfer assembly (ITA) and difficulty making night sight adjustments hampered tracking. Gunners indicated some concern because of control deadband (the non-responsive center portion of control movement) and they felt it was difficult to track evasive targets. Use of the collimator and boresighting in general were viewed as problems. All persons registered concern about the inadequacy of backup turret power capability.

The gunner's seat was judged difficult to adjust and was uncomfortable in part because of no back rest. Crew members indicated difficulties and hazards getting in and out of the turret, problems of exposed wiring and hydraulic lines, and the hazard of being thrown around and hitting things (sharp edges and knobs) while underway.

Most problems noted by drivers related to loss in vehicle capabilities compared with the standard M113A1. Drivers were very concerned about: vehicle power, the ability of the ITV to climb hills fast, and operate in the mud. They saw the rise in center of gravity as a problem as were the loss of acceleration, and mobility.

The main problems indicated by loaders and observers were: headset cords (not long enough or in the way while loading missiles or doing other jobs), sharp edges in the work area, inability to see out enough and difficulty throwing missile casing out of vehicle. Airguard and observation from the cargo hatch were almost impossible, even with the high stow launcher position. Observers were unable to stand upright. Attempts to observe or navigate from the cargo hatch while travelling were unsuccessful.

c. Quality of Design/Redesign Requirements Questionnaire

Quality of design ratings indicated pieces of equipment or design features that were excellent at one extreme or serious problems needing change or improvement at the other extreme. Items rated in the serious problem range should receive redesign attention and so are highlighted here.

The squad leader's seat and the CVD were both seen as requiring redesign. The seat should have a back and be spring loaded to fold away to permit easy entrance and exit especially by the driver. The general feeling about the CVD was that although the device concept is good the CVD has too many limitations. It is not fully responsive to the squad leader's mission needs.

The things most criticized by gunners related to the viewing system - most specifically boresighting and night sight adjustments, and the difficulty exchanging collant bottles. The imagetransfer assembly (ITA) was a problem because of vibration and fogging. Worst of all was the rating of the turret backup power system -- seen as definitely needing redesign.

Crew members were sufficiently concerned about hill climbing, speed, power, and maneuverability that they are among the features of the ITV called serious problems that should be changed. They also did not like the limitation that required loading a 100 round ammunition box (rather than 200) into the M60 machine gun whenever the dual launcher is to be used. This coupled with the difficulty in being able to fire small arms from the ITV appear to limit seriously the crew's ability to suppress personnel and/or to defend the vehicle if that should become necessary.

Recognizing the crowdedness of all vehicles like the ITV, little attention has been given to crew member's repeated complaints in these areas. It is a fact, however, that they gave poor ratings to conditions such as space to operate while wearing winter clothing - or even when wearing normal personal gear. The personal storage situation (clothing, etc.) is also rated as serious and probably should receive attention.

d. Training

Test subjects were able to meet the training standards established at the DT III (AMSA) and at the OT III (OTEA) as a result of programs presented by the Armor and Infantry schools. A second training program was required at the OT III, Phase B, in January, 1978. The schools presented refresher training and training for replacement test subjects needed because of the duration of the test. Again all test subjects attained the performance standards for timed tasks and gunner qualification.

Key training issues identified for both test sites were evaluated in terms of established standards, adequate availability of necessary equipment for training, and applicability to future required training for ITV crew members. The evaluation of training at the DT III and OT III sites allowed the following conclusions:

- The training programs for new equipment training proved adequate to meet established test standards for participating personnel.

● Basic ITV training should require five (5) days. An additional three days is necessary for tactics training and for operational experience.

● There was no evidence that indicates negative transfer of skills between the TOW and ITV tracking systems. There does appear to be some degree of positive transfer for the gunner practicing with both systems.

● There was a larger decrement in ITV tracking skill than was found for TOW skill. Both may be maintained by practicing tracking tasks on the respective systems. Test participants indicated that intervals between ITV practice for skill maintenance should be no more than one week. TOW practice sessions should be twice monthly. Individual gunners may require additional practice.

● The Evasive Target Simulator (ETS) can train gunners to M70 system standards.

The Evasive Target Simulator (ETS), used with the M70, has a tremendous potential for unit training and its development is strongly endorsed by ARI. It allows the unit commander freedom to train in confined areas whenever his own resources are available. There is no need to schedule ranges and additional equipment for training.

CONCLUSIONS AND RECOMMENDATIONS

In sum, the ITV was judged to be good in concept but to be lacking in durability and reliability. Crew members felt the vehicle sometimes could not keep up or go where other vehicles could go. They judged the ITV to be somewhat slow getting into or out of action. There was a frequent need for boresighting. Night sight controls were unsatisfactory, as was turret backup power. Command and control problems were evident at the squad leader's station. The commanders viewing device (CVD) needs improvement. The cavalry scout mission on the move is difficult at best.

In the body of this report data are presented for each duty position. Soldier's problem identifications and recommendations are detailed. Training data and recommendations are also given. The Evasive Target Simulator (ETS) device was evaluated and is highly recommended for further development.

The detailed results should be carefully studied for possible improvements of the ITV. There is a tendency for user data to have altogether too little impact on final equipment design. The soldiers who participated in OT/DT III were a valuable resource for expert user feedback on ITV problems, solutions and modifications. Attending to their advice could greatly improve the final vehicle.

RESEARCH PLAN

ARI-Benning and resident contractor (Litton Mellonics) staff members participated actively at DT III (White Sands Missile Range) and OT III (Yakima Firing Center). ARI was a full member of the Test Directorate at OT III. Based upon observations at both sites, plans were generated to gather questionnaire, interview and observational data from ITV users, test staff and opposition force (threat) personnel.

TEST INSTRUMENTS

The basic philosophy guiding the development of questionnaire materials was to be certain that every potential significant problem was included in the questionnaire package so that every person would have the opportunity to evaluate each item. In practice this results in an iterative test development process that is complete only near the end of a field test. It also results in questionnaires that are closed ended and specific rather than open ended and general (thus requiring written comments that are difficult to quantify). This iterative type of instrument development is well suited to a test such as the ITV OT III where the most useful final troop feedback should come late in the program when soldiers have experienced the full range of system employment (including, e.g., field exercises against a threat force, lengthy buttoned-up operations, and live missile firings).

After gathering questionnaire data from such instruments, interviews can then be used to add substance and detail to the problems that emerge as important from the questionnaires.

a. Questionnaires

The following major questionnaires were developed for use in the ITV study effort:

- ITV Human Factors Questionnaire
- ITV Ratings
- Quality of Design/Redesign Requirements Questionnaire
- Training Questionnaires

(1) ITV Human Factors Questionnaire. This questionnaire (see Appendix A) required each crew member to indicate the extent to which various items had been a problem to him (0=no problem to 3 = a serious problem). It began with a general section of items applicable to all persons. It then had a portion that pertained to each specific duty position (i.e., squad leader, gunner, driver, loader, observer). Every potential problem area that had emerged by near the end of OT/DT III was written into the questionnaire.

(2) ITV Ratings. This questionnaire (see Appendix A) required test participants to rate the ITV on 29 different categories ranging from safety of the weapons to an overall rating of the ITV for combat use. It used an answer format ranging from "1 = excellent", to "5 = very poor".

(3) Quality of Design/Redesign Requirements Questionnaire. This instrument (see Appendix A) was developed to identify design related problems with the ITV system and was particularly geared to obtaining suggestions about how to correct those flaws detected by the users. One hundred items were included (e.g., gunner's seat, frequency that boresighting is required, deadband in gunner's control). Answers ranged from "1 = excellent as is - I like it" to "5 = very serious problem - item must be changed before production".

(4) Training Questionnaires. These questionnaires (see Appendix A) were designed to determine suitability and completeness of the training program prior to entry into the DT/OT III test activities, later at the point of required retraining (after the long delay due to vehicle modifications) and finally at the end of all OT III test activities. Participants gave ratings of the instruction and practice given in the training for ITV use and about perceived needs/deficiencies in the program.

Other questionnaires were developed to aid OTEA in their evaluations. These included: maintenance and repair, swim test, and NOD/LR inquiries. There was also a questionnaire to determine troop morale and possible negative bias stemming from the lengthy delays in carrying out the OT III activities.

b. Interviews

Interviews were conducted to obtain additional information about training at various points during OT/DT III. Other interviews were conducted, primarily at the end of OT III to clarify and add detail to human factors and redesign questionnaire answers.

c. Observations

Observations were made during the several trips to both test sites. Many informal observations of and interactions with troop, threat force and test support personnel were conducted during key test activities.

d. Other Data

Other data are reported and integrated in the results section as appropriate, e.g., tracking and live fire performance scores. While ARI did not collect these data they are greatly relevant to the basic data of this report.

SUBJECTS

The persons who contributed data to the results reported here were:

- Test subjects from DT III,TOW/ITV gunners (N = 12)
- Test subjects from OT III
 - Mechanized Infantry crew members (N = 24)
 - Armored Cavalry crew members (N = 10)
- Threat Force Personnel (all Tank Commanders or Company Officers, N=14)
- Project personnel (e.g., Controllers, Data Collectors, Mechanics, N=44)

Complete data were gathered from most of the ITV user soldiers. Other persons were given those questionnaire materials applicable to their activities and/or knowledge.

RESULTS

DATA CONSIDERATIONS

The ITVs as they were configured for testing at both the OT and DT test sites from July through November 1977, (Phase A) suffered extensive mechanical problems which were repaired, modified, and/or redesigned for OT III, Phase B, which ran from January through March, 1978. In cases where these changes eliminated a prior problem, the problem will not be addressed in the text of this report.

The majority of the OT III test subjects participated in both phases A and B of the test, but lengthy program delays resulted in some personnel turnover. Where longitudinal (repeated measure) data were deemed appropriate for analyses, only those persons present for the entire study were included.

The study delays plus equipment failures also presumably had an effect on troop morale. For this reason it appeared desirable to measure the attitudes and possible negative bias of test subjects toward the ITV program when they returned for the beginning of Phase B. The subjects responded generally in a neutral to favorable manner toward the ITV vehicle and the test as shown in the questionnaire summary (Appendix A, Bias Questionnaire). New subjects for Phase B and subjects with prior exposure to the ITV recorded similar attitudes so they were combined as a subject pool in most data collections.

In collecting the human factors and training related material concerning the ITV, many aspects of system operation were examined. Some concerns identified were man/machine problems which have been associated with M113A1 armored personnel carriers (APCs) in general since the inception of their use. Such problems as: e.g., storage space, crew comfort, heat in the summer, cold in the winter, and rain leaks, are not specific to the ITV. These problems will continue to plague APCs but do not merit emphasis in this report. They were concerns of the test subjects in this study and so will be addressed. However, priority will be given to concerns more critical to the ITV's mission performance capability.

The foremost concern of test subjects, site personnel, and ARI Benning observers is the lack of reliability of the ITV throughout testing. While much of this may be reversable with ITV improvements, judgments of unreliability permeate the results to be reported here.

Considerable questionnaire data were collected ranging from general to highly specific. The results to follow will briefly cover the most

important findings. Complete responses of various answering groups (e.g. squad leaders, threat force) can be found in the tables for those interested in detailed data examination.

OVERALL ITV RATINGS

a. Squad Leaders and Gunners

Results of the overall ITV Ratings for various groups of respondents are shown in Table 1. The user group in this sample with the greatest responsibility and probably the broadest knowledge of the capability of the ITV was the ITV squad leaders (track commanders). Their overall average rating of the ITV for combat use was 4.4, midway between "poor" and "very poor". They rated 17 of the 29 items 3.0 or worse (between "Fair" and "Very Poor"), indicating that they found considerable fault with the vehicle. Only in the areas of ability to track and hit targets and weapons safety did the ratings fall in the "Good" range. Ratings that fall in the "Poor" range or worse obviously deserve careful attention from designers and decision makers. Squad leaders were concerned about ability to keep the ITV operational (e.g., ruggedness, reliability, vulnerability, keeping the missile system boresighted). They were also concerned about the ITV's ability to keep up with and go where other combined force vehicles could go (climbing, etc.). Combining the gunner's responses with those of the squad leaders did not change the picture much (both groups served as ITV gunners during the test). In fact, even adding all of the soldiers who served as ITV crew members did not reduce the severity of the overall ratings very much. In sum, ITV crew members were seriously concerned that the ITV is not ready to be fielded in its current form (as of OT III).

b. Threat Force

Another group whose opinions merit examination is the threat force. These tank commanders served as opponents of the ITV during the various field exercises throughout OT III. Among those areas they felt competent to rate, 17 of 20 were rated "Fair" or worse. From questionnaire comments and in discussions with threat force personnel, the view emerged that the ITV in its initial defilade defensive position would be effective but when it had to move to an alternate firing position or otherwise had to move on the battlefield it would be vulnerable and easily ambushed by tanks. They keyed on the amount of time it takes the ITV to launch a missile after stopping from movement.

Table 1
Summary of Mean ITV Ratings for Different Groupings of Respondents.
Answers are: 1=Excellent, 2=Good, 3=Fair, 4=Poor, and 5=Very Poor

	SQUAD LEADERS				GUNNERS				SQUAD LEADERS & GUNNERS				THREAT FORCE				TOTALS			
	Inf	Cav	All	AT	MECH	Cav	DT III	Inf	Cav	All	N=12	N=4	N=16	N=14	OT III Crews	N=33	Other Staff	All OT III N=77		
	N=6	N=2	N=8	N=4	N=2	N=2	N=12	N=2	N=4	N=4	N=12	N=4	N=16	N=14	N=33	N=44	N=44	N=77		
1. Safety of the weapons.	2.5	1.5	2.2	2.5	3.5	2.0	2.1	2.7	1.7	2.4	-	-	2.7	-	2.3	2.5	-	-		
2. Safety of turret operations.	3.0	2.0	2.7	2.7	3.5	2.0	2.2	3.0	2.0	2.7	-	-	2.9	-	2.4	2.6	-	-		
3. Ability to detect targets.	3.0	1.5	2.6	2.2	2.5	2.5	2.3	2.7	2.0	2.5	-	-	2.6	-	2.5	2.5	-	-		
4. Ability to identify targets.	3.0	2.0	2.7	2.7	3.5	2.0	2.3	3.0	2.0	2.7	-	-	2.7	-	2.3	2.5	-	-		
5. Ability to track targets.	2.0	2.0	2.0	1.7	2.0	2.5	2.3	1.9	2.2	2.0	-	-	2.0	-	2.0	2.0	-	-		
6. Ability to hit targets.	2.0	2.0	2.0	1.5	2.5	2.0	2.0	1.9	2.0	1.9	-	-	1.9	-	2.1	2.0	-	-		
7. Ability to keep the system boresighted.	4.3	3.0	4.0	3.7	5.0	4.5	-	4.2	3.7	4.1	-	-	4.0	-	3.4	3.7	-	-		
8. Ability to move—without need for new boresighting.	4.7	3.0	4.2	3.7	5.0	4.0	-	4.4	3.5	4.2	-	-	4.1	-	3.4	3.7	-	-		
9. Ability to keep optics clean —.	3.5	3.0	3.4	3.0	3.0	2.5	-	3.2	2.7	3.1	-	-	3.2	-	3.4	3.3	-	-		
10. Vulnerability of the ITV.	4.2	3.5	4.0	3.5	4.5	4.5	3.1	4.0	4.0	4.0	-	-	3.5	-	3.9	3.2	3.5	-		
11. Protection for the gunner.	2.3	4.0	2.7	2.0	2.5	3.0	2.1	2.2	3.5	2.6	-	-	2.4	-	2.5	2.1	2.3	-		
12. Ruggedness of the ITV.	4.7	3.5	4.4	4.0	4.5	4.5	3.1	4.4	4.0	4.3	-	-	3.9	-	3.8	3.6	-	-		
13. Reliability of the ITV.	4.7	4.0	4.5	4.5	5.0	4.5	3.2	4.7	4.2	4.6	-	-	4.0	-	4.2	3.6	-	-		
14. Ability to set up quickly to fire.	2.5	4.0	2.9	2.7	2.0	4.5	1.9	2.5	4.2	2.9	-	-	3.7	-	3.0	3.0	-	-		
15. Ability to stow launcher and depart firing areas quickly.	2.5	4.0	2.9	3.0	2.0	4.5	2.6	2.6	4.2	3.0	-	-	3.6	-	3.0	2.9	-	-		
16. Ability to reload quickly.	2.8	2.5	2.7	2.5	2.0	4.0	2.2	2.6	3.2	2.7	-	-	3.0	-	2.6	2.5	-	-		
17. Overall design for crew member ease of use of the ITV.	4.2	3.0	3.9	3.2	4.5	3.0	2.6	3.9	3.0	3.7	-	-	3.7	-	3.5	3.1	3.3	-		
18. Ability to operate in snow and ice.	3.3	3.5	3.4	3.5	4.0	2.5	-	3.5	3.0	3.4	-	-	3.5	-	3.4	3.0	3.2	-		

Table 1 (Cont'd)

	SQUAD LEADERS				GUNNERS				LEADERS & GUNNERS				SQUAD				THREAT FORCE				TOTALS			
	Inf Cav N=6	A11 N=2	AT N=4	Mech N=2	Inf Cav N=2	A11 N=12	AT N=2	Cav N=4	Inf Cav N=12	A11 N=4	AT N=16	Cav N=14	Inf Cav N=33	A11 N=44	AT N=14	Cav N=16	Inf Cav N=33	A11 N=77	Other Staff N=44	OT III Crews N=33	OT III Crews N=14	Other Staff N=77		
19.	Ability to operate in rain and mud.	3.3	4.5	3.6	3.2	4.0	3.0	-	3.4	3.7	3.5	3.5	3.6	3.1	3.1	3.3								
20.	Ability to keep the ITV operational.	4.3	3.5	4.1	4.0	5.0	4.0	-	4.3	3.7	4.2	4.6	4.6	3.8	3.8	3.8								
21.	Ability to avoid detection.	3.8	2.5	3.5	3.0	5.0	3.0	-	3.6	2.7	3.4	3.7	3.3	3.1	3.1	3.2								
22.	Ability to see well in daytime.	2.5	2.0	2.4	2.0	2.5	2.0	-	2.3	2.0	2.2	3.1	2.1	2.1	2.3	2.2								
23.	Ability to see well at night.	3.2	2.0	2.9	3.5	3.0	2.5	-	3.2	2.2	3.0	2.1	2.1	3.0	2.6	2.8								
24.	Ability to keep up with other vehicles.	4.5	2.5	4.0	3.5	4.5	4.0	-	4.2	3.2	3.9	3.2	3.2	3.7	2.7	3.2								
25.	Ability to go where other vehicles can go.	4.0	4.0	4.0	3.5	4.5	4.5	-	3.9	4.2	4.0	2.9	2.9	3.9	2.7	3.2								
26.	Ability to get in and out of vehicle.	3.3	3.0	3.2	3.2	3.0	2.5	-	3.2	2.7	3.1	3.1	3.1	3.1	2.7	2.9								
27.	Ability to observe while moving.	3.8	2.5	3.5	4.0	4.5	3.5	-	4.0	3.0	3.7	3.3	3.3	3.6	3.2	3.4								
28.	Ability to operate — In rugged and sloping areas.	3.8	2.5	3.5	3.7	5.0	4.0	-	4.0	3.2	3.8	3.9	3.8	3.2	3.2	3.5								
29.	— give an overall rating of the ITV — for combat use.	4.5	4.0	4.4	3.5	5.0	4.5	3.4	4.2	4.2	4.2	3.5	4.2	3.2	3.6									

HUMAN FACTORS QUESTIONNAIRE

The first section of the Human Factors Questionnaire contained 75 items that applied generally to all crew members regardless of position. Answers to these questions by various groupings of crew members are shown in Table 2. Respondents marked each item to indicate how much of a problem each had been during the testing (0=no problem, 1=a minor problem, 2=a moderate problem, 3=a serious problem). Only those items rated in the moderate to serious problem range (average rating of 1.6 or higher) will be summarized.

a. All OT III Crew Members

With all OT III crew members combined several areas drew concern.

(1) Safety. Several safety problems that are typical of cramped armored vehicles were highlighted: objects sticking out, clothing and web gear snagging, and amount of crash padding. The rotating bottom plate of the turret was seen as dangerous to feet and because objects can get underneath.

(2) Load Plan. The loading plan of the ITV was criticized. Equipment is subject to damage because of inadequate storage and because of loose items on the floor. Crew members were particularly bothered by having to carry personal gear externally. Inability to get at their personal weapons where stored was also seen as a problem.

(3) Discomfort. The M113A1 is generally regarded as uncomfortable-the ITV is obviously no better. ITV problem areas were: vibration, low temperature, being bounced around, and general discomfort when in the vehicle for a long time or riding at high speed.

(4) Crowding. Crowding and cramped space are always problems in multimanned vehicles, and the ITV was no exception. Additional problems in the ITV were the ability to get over or by other crew members seats and difficulty operating wearing extra gear (e.g., CBR protection).

(5) Vehicle. Several vehicle characteristics were problems to crew members. Noted particularly as inadequate were: power of the engine, speed, maneuverability, ability to climb hills and to get into and out of defilade positions. There was also the typical problem of mud on the periscopes (e.g., on the ramp) making outside visibility difficult. Finally, communication equipment often causes problems. Breakdowns occurred with the ITV system and crew members were bothered by headset cords getting in the way (gunner and loaders stations).

Table 2
SUMMARY OF MEAN HUMAN FACTORS QUESTIONNAIRE GENERAL QUESTIONS FOR DIFFERENT GROUP OF RESPONDENTS
ANSWERS ARE: 0 = NO PROBLEM, 1 = A MINOR PROBLEM, 2 = A MODERATE PROBLEM, 3 = A SERIOUS PROBLEM

HUMAN FACTORS	GENERAL ITEMS	SQUAD LEADERS				GUNNERS				SQUAD LEADERS & GUNNERS				TOTAL N=33	
		N=6		N=2		N=4		N=2		N=12		N=4			
		OT IIII INF SL	OT IIII CAV SL	OT IIII ALL SG	AT G	OT IIII MECH G	CAV G	OT IIII G	DT IIII SL & G	OT IIII INF CAV	OT IIII CAV	OT IIII SL & G	INF & CAV		
1.	Objects sticking out - Vehicle safety hazards	1.8	2.0	1.9	1.2	1.5	0.5	1.2	1.5	1.2	1.5	1.2	1.5	1.7	
2.	Amount of padding on periscopes	1.5	0.5	1.2	1.0	1.5	0.5	0.3	1.3	0.5	1.1	1.1	1.2	1.2	
3.	Unsafe storage of any weapons	2.0	2.5	2.1	1.0	0.5	2.5	0.0	1.4	2.5	1.7	1.7	1.4	1.4	
4.	Unsafe conditions weapons being fired	1.2	0.0	0.9	0.2	1.5	0.0	0.2	0.9	0.0	0.7	0.7	0.7	0.7	
5.	Controls activated accidentally - Safety hazard	1.2	1.5	1.2	0.7	1.0	0.5	0.8	1.0	1.0	1.0	1.0	1.0	1.0	
6.	Amount of safety crash padding in vehicle	1.8	0.5	1.5	1.2	2.5	0.0	1.5	1.7	0.2	1.4	1.4	1.9	1.9	
7.	Not enough air when vehicle buttoned up	2.2	0.0	1.6	0.2	0.0	0.0	0.4	1.2	0.0	0.9	0.9	1.3	1.3	
8.	Noise caused trouble hearing communications	1.3	1.0	1.2	1.0	2.0	1.0	0.5	1.3	1.0	1.2	1.2	1.4	1.4	
9.	Noise annoying to you	1.3	1.0	1.2	1.2	2.0	1.5	0.7	1.4	1.2	1.4	1.4	1.5	1.5	
10.	Noise caused hearing problems lasting after noise stopped	0.8	0.0	0.6	0.0	0.0	1.5	0.2	0.4	0.7	0.5	0.5	0.9	0.9	
11.	Amount of lighting inside vehicle	1.3	1.5	1.4	0.0	0.5	1.5	1.1	0.7	1.5	1.5	1.5	1.1	1.1	
12.	Placement of lights inside vehicle	1.7	1.5	1.6	0.0	2.5	1.5	1.0	1.2	1.3	1.3	1.3	1.3	1.3	
13.	Adequacy of lighting at duty position	0.7	0.0	0.5	0.2	2.0	1.5	0.7	0.7	0.7	0.7	0.7	1.1	1.1	
14.	Something about vehicle—riding very fatiguing	1.3	1.5	1.4	1.7	2.5	1.5	1.3	1.7	1.5	1.6	1.6	1.5	1.5	
15.	General discomfort in vehicle short time periods	1.3	0.0	1.0	0.5	2.0	1.0	0.4	1.2	0.5	1.0	1.0	1.0	1.0	
16.	General discomfort in vehicle long time periods	2.3	1.5	2.1	1.2	2.5	2.0	1.2	2.0	1.7	1.9	1.9	2.1	2.1	
17.	Discomfort riding at slow speeds	1.0	0.0	0.7	0.2	0.5	1.0	0.2	0.7	0.5	0.6	0.6	0.9	0.9	
18.	Discomfort riding at high speeds	2.3	1.5	2.1	1.5	2.5	2.0	1.1	2.1	1.7	2.0	2.0	2.0	2.0	
19.	Crowding/crammed space in vehicle	2.8	1.5	2.5	2.2	2.5	2.5	1.2	2.6	2.0	2.4	2.5	2.5	2.5	
20.	High temperature inside vehicle	2.5	0.0	1.9	0.5	2.5	0.5	1.2	1.8	0.2	1.4	1.4	1.6	1.6	
21.	Low temperature inside vehicle	2.0	0.0	1.5	0.5	2.5	1.0	0.7	1.6	0.5	1.1	1.1	1.1	1.1	
22.	Any conditions made you feel motion sick	1.0	0.0	0.7	0.5	2.0	1.5	0.1	1.0	0.7	0.9	0.9	1.1	1.1	
23.	Vibration in the vehicle	2.0	0.0	1.5	0.7	2.5	0.6	1.7	1.2	1.6	1.6	1.6	1.8	1.8	
24.	Fumes from missiles during live fire	1.3	0.0	1.0	0.7	0.5	0.0	1.0	0.0	0.7	0.9	0.9	0.9	0.9	
25.	Fumes from missiles during live fire	0.8	0.0	0.6	0.2	1.0	0.0	0.2	0.7	0.0	0.5	0.5	0.5	0.5	

Table 2 (Cont'd)

HUMAN FACTORS	GENERAL ITEMS	SQUAD LEADERS						GUNNERS						SQUAD LEADERS & GUNNERS									
		N=6			N=2			N=4			N=2			N=12			N=4			N=16			
		OT IIII	OT III	AT G	CAV SL	ALL SG	INF	OT IIII	OT III	MECH G	CAV G	OT IIII	OT III	SL & G	CAV	OT IIII	OT III	SL & G	CAV	OT IIII	OT III	SL & G	CAV
26.	Amount of ventilation in vehicle	1.7	0.0	1.2	0.0	0.5	0.5	0.5	0.5	0.5	0.5	0.7	0.9	0.2	0.7	0.7	0.2	0.7	0.7	0.9	0.2	0.7	1.0
27.	Being bounced around vehicle under way	1.8	1.0	1.6	1.0	2.5	2.0	—	—	—	—	1.7	1.7	1.5	1.6	1.7	1.7	0.0	0.0	0.0	0.0	0.0	1.9
28.	Outside lights on vehicle caused glare	0.0	0.0	0.0	0.0	—	—	0.0	0.0	—	—	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
29.	Getting cramped hard dismount/do your job	0.8	1.0	0.9	1.0	2.0	2.5	0.7	0.7	2.0	2.5	1.1	1.1	1.7	1.2	1.2	1.2	1.1	1.7	1.2	1.2	1.2	1.4
30.	Too little leg room	2.3	0.0	1.7	0.7	2.0	2.5	2.0	2.0	2.0	2.0	1.7	1.7	1.6	1.6	1.7	1.7	1.6	1.7	1.6	1.6	1.6	1.5
31.	Too little head room	1.8	1.5	1.7	0.5	2.0	2.5	1.0	1.0	2.0	2.0	1.0	1.0	1.4	1.4	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.5
32.	Too little hip or shoulder room	2.3	0.0	1.7	0.2	1.5	2.0	1.5	1.5	2.0	2.0	1.5	1.5	1.4	1.4	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.4
33.	Loading plan of vehicle	2.8	3.0	2.9	0.7	2.5	2.5	—	—	—	—	0.4	0.4	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
34.	Ability to get individual weapon when required	2.8	3.0	2.9	0.7	2.5	2.5	—	—	—	—	2.1	2.1	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	1.8
35.	Adequacy & accessibility of safety/emergency equipment	1.3	1.5	1.4	0.2	3.0	0.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
36.	Ability to care for injured persons in vehicle	3.0	1.0	2.3	0.2	1.5	0.5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
37.	Headset/helmet design for comfort	1.7	0.5	1.4	0.2	0.0	0.0	1.0	1.0	0.0	0.0	0.2	0.2	0.9	0.7	0.7	0.7	0.9	0.7	0.9	0.7	0.9	0.9
38.	Headset/helmet difficulties during dismount	0.5	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.4	0.6	0.2	0.2	0.2	0.6	0.2	0.6	0.2	0.6	0.6
39.	Headset cord in way while doing my job	2.7	1.5	2.4	0.2	1.0	1.0	2.0	2.0	1.0	1.0	1.2	1.2	1.6	1.7	1.6	1.7	1.6	1.7	1.6	1.7	1.6	1.6
40.	Malfunctions f radio/intercom system	1.8	0.0	1.4	2.0	2.5	0.0	0.0	0.0	0.0	0.0	0.4	0.4	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7
41.	Broken headsets	1.0	0.0	0.8	0.7	1.0	1.0	0.5	0.5	0.7	0.7	0.5	0.5	0.9	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.3
42.	Ramp operation or obstructions	0.5	0.0	0.4	0.2	1.0	1.5	0.5	0.5	1.0	1.0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.7
43.	Difficulties adjusting your seat	1.2	3.0	1.6	1.2	0.5	1.0	0.5	0.5	1.0	1.0	0.2	0.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
44.	Power in engine of vehicle	2.5	1.5	2.2	1.0	3.0	1.5	0.3	0.3	1.5	1.5	0.3	0.3	2.2	1.5	1.5	1.5	2.0	2.0	2.0	2.0	2.0	2.0
45.	Feeling motion sick when buttoned up	1.0	0.0	0.7	0.5	1.5	1.5	0.5	0.5	1.5	1.5	0.0	0.0	0.9	0.7	0.7	0.9	0.7	0.9	0.7	0.9	0.7	1.0
46.	Feeling motion sick riding long periods high speeds	1.0	0.0	0.7	0.5	2.0	1.5	0.0	0.0	1.5	1.5	0.0	0.0	1.0	0.7	0.7	0.9	0.7	0.9	0.7	0.9	0.7	1.2
47.	Difficulty to get to your seat or riding position	1.7	1.5	1.6	0.7	1.5	1.0	0.7	0.7	1.0	1.0	1.1	1.1	1.2	1.3	1.3	1.3	1.2	1.3	1.2	1.3	1.2	1.3
48.	Difficulty getting out vehicle from your seat	1.5	1.5	1.5	0.2	2.0	1.0	1.0	1.0	1.0	1.0	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1
49.	Clothing, web gear snagging entering/leaving vehicle	2.2	3.0	2.4	1.7	2.0	2.0	1.0	1.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.1
50.	Not enough room put feet while sitting on my seat	1.7	1.5	1.6	0.2	1.5	2.0	0.5	0.5	2.0	2.0	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.0

Table 2 (Cont'd)

HUMAN FACTORS	GENERAL ITEMS	SQUAD LEADERS				GUNNERS				SQUAD LEADERS & GUNNERS				TOTAL N-33 N-16 N-12 N-4 N-2	
		N-6		N-2		N-8		N-4		N-2		N-12			
		OT III	INF SL	OT III	CAV SL	OT III	ALL SG	OT III	MECH G	OT III	CAV G	OT III	SL & G		
51.	Difficulty getting over or by other's seats	2.3	1.5	2.1		0.5		1.5		0.5		1.6	1.0	1.4	
52.	Difficulty seeing through periscopes (mud)	2.3	2.5	2.4		0.5		2.5		0.5		1.7	1.5	1.7	
53.	Difficulty seeing periscopes fogged	1.5	1.0	1.4		0.7		1.5		1.0		1.2	1.0	1.3	
54.	Difficulty seeing periscopes vibrated	1.2	0.0	0.9		0.2		0.5		0.5		0.7	0.4	0.6	
55.	Difficulty seeing periscopes Glare	1.0	1.0	1.0		0.5		0.0		0.5		0.7	0.7	0.9	
56.	Difficulty with loose items on floor	2.0	1.5	1.9		1.5		2.0		0.5		1.8	1.0	1.6	
57.	Speed of vehicle	2.8	0.0	2.1		1.5		3.0		1.0		2.4	0.5	1.9	
58.	Maneuverability of vehicle	2.2	3.0	2.4		1.2		2.0		2.5		1.8	2.7	2.1	
59.	Ability vehicle climb hills	3.0	3.0	3.0		1.5		3.0		2.5		2.5	2.7	2.6	
60.	Ability to get out of steep defilade	2.5	3.0	2.6		1.2		2.5		2.5		2.1	2.7	2.3	
61.	Danger to squad during rotation turret	1.8	0.0	1.4		0.5		1.5		0.5		0.7	1.3	1.0	
62.	Danger to operate ITV wearing CCR gear	2.7	1.5	2.3		1.0		2.5		1.0		0.2	1.2	1.6	
63.	Ability to operate ITV wearing cold gear	2.3	2.5	2.4		1.5		2.5		0.5		2.1	1.5	1.5	
64.	Danger due to placement smoke grenade launchers	0.6	0.5	0.6		0.3		0.0		0.0		0.4	0.2	0.3	
65.	Danger due to closeness TC's position to turret	2.8	0.0	2.1		0.7		1.0		0.5		1.8	0.2	1.5	
66.	Possibility setting foot caught turret rotating	2.7	1.0	2.2		0.5		2.5		0.5		1.0	1.9	1.6	
67.	Things getting underneath turret on floor of vehicle	2.7	1.5	2.4		1.2		3.0		0.5		1.3	2.2	1.9	
68.	Overpressure during missile firing	0.5	0.0	0.3		0.2		0.0		0.0		0.3	0.0	0.5	
69.	Sufficient numbers/locations of hand holds	1.3	0.5	1.1		1.0		1.5		0.6		1.2	1.0	1.1	
70.	Adequacy working space at duty station	2.8	0.0	2.1		0.2		0.0		2.0		0.7	1.5	1.4	
71.	M16A1 damage due to inadequate storage racks	0.3	1.5	0.6		0.0		0.0		1.0		0.2	1.2	0.7	
72.	Damage to other equipment inadequate storage	2.8	0.0	2.1		1.0		1.5		2.0		0.2	1.0	1.7	
73.	Difficulty keeping oriented while inside vehicle	2.2	1.5	2.0		0.5		1.5		0.0		—	1.5	0.7	
74.	Damage to personal gear — where stored	2.7	1.5	2.4		1.5		3.0		2.5		—	2.3	2.2	
75.	Sharp points on cam rail around gunners cupula	1.8	2.5	2.0		1.0		1.5		1.0		1.5	1.7	1.6	

b. Squad Leaders

The squad leaders were generally the most knowledgeable and concerned of the crew members because of their responsibilities. In Table 2 note that their problem judgments tend to be higher than those of other crew members. There are some answer differences between infantry and cavalry squad leaders. One reason is that the cavalry squad leader would normally ride in the turret instead of the squad leader's station. Another is the mission differences presumably making the cavalry more concerned about rapid movement and quick engagements and departures.

Table 3 gives a comparison of infantry and cavalry squad leader responses to Human Factors Questionnaire items applicable to that crew position. Many problems were voiced (40 of the 61 items were rated 2.0 or worse).

(1) Commander's Viewing Device (CVD). The infantry track commander's station utilized a periscope (the CVD) which was not employed by the cavalry. The infantry squad leaders found considerable fault with the device. The station affords no view of the battlefield except through the CVD. Seeing well in the daytime is difficult, at night worse (because of no night vision device capability) and on the move nearly impossible. Complaints and ratings are detailed in Table 3. They include: difficulty seeing because of obstructions, glare, dust, rain, etc., too little magnification, and narrow field of view, and difficulty estimating range, identifying and prioritizing targets, and covering the area of responsibility.

(2) The Seat. Comments about the gunner's seat (occupied by cavalry squad leaders) will be made later. From data in Table 2 there appear to be several problems for the track commander's seat: head, leg, hip or shoulder room, difficulty getting to the seat, and danger because of closeness of the turret. Answers from Table 3 indicate the seat was also viewed as too close to the driver. The seat was difficult to stay on, it had no back support and was unadjustable and uncomfortable.

(3) The Squad Leader's Station. Squad leaders indicated that there were problems seeing well enough to do their jobs (e.g., infantry = 3.0). For the infantry it was difficult to carry out command and control functions (with crew or other vehicles), and to navigate (either with the CVD or from the loader's hatch). All squad leaders said there were serious problems due to too little space in the squad leader's station and because of difficulty reaching their personal weapons where stored.

Table 3

Summary of Mean Answers to Squad Leader Questions from the Human Factors Questionnaire. Answers are: 0 = No Problem, 1 = A Minor Problem, 2 = A Moderate Problem, and 3 = a Serious Problem

	<u>INF</u>	<u>CAV</u>	<u>BOTH</u>
1. Ability to see at night from the Squad Leader's (SL's) seat.	3.0	-	-
2. Ability to see in daylight from the SL's seat.	2.2	-	-
3. Ability to see in bad weather from the SL's seat.	2.5	-	-
4. Difficulty seeing through the commander's viewing device (CVD) because of the sun's glare.	2.2	-	-
5. Difficulty seeing through the CVD because of heatwaves.	1.2	-	-
6. Difficulty seeing through the CVD because of dust, smoke or haze.	2.7	-	-
7. Difficulty seeing through the CVD because of vibration.	2.3	-	-
8. Difficulty seeing through the CVD because of background clutter.	1.3	-	-
9. Difficulty seeing through the CVD because of glare.	1.3	-	-
10. Difficulty seeing through the CVD because of dirt, mud, or debris on the lenses.	1.3	-	-
11. Difficulty seeing through the CVD because of rain, snow or fog on the lenses.	2.2	-	-
12. Difficulty seeing through the CVD because of unclear optics.	1.7	-	-
13. Difficulty seeing through the CVD because of too little magnification.	2.2	-	-
14. Difficulty seeing through the CVD because the field of view was too small.	2.3	-	-
15. Ability to detect targets with the CVD.	1.5	-	-
16. Ability to identify targets with the CVD.	2.0	-	-

Table 3 (cont'd)

	<u>INF</u>	<u>CAV</u>	<u>BOTH</u>
17. Ability to prioritize targets using the CVD.	2.0	-	-
18. Ability to keep track of your full area of battlefield responsibility using the CVD.	2.5	-	-
19. Difficulty seeing through the CVD while the vehicle is moving.	3.0	-	-
20. Difficulty seeing through the CVD at night.	3.0	-	-
21. Ability to estimate range to a target using the CVD.	2.5	-	-
22. Obstructions blocking your view when you are trying to see using the CVD.	2.8	-	-
23. SL's seat too close to the driver's seat.	1.8	0.0	1.6
24. SL's seat too close to the turret.	3.0	3.0	3.0
25. Danger to the SL when the turret is moving.	2.5	3.0	2.6
26. Comfort while sitting on the SL's seat.	2.8	3.0	2.9
27. Ability to stay on the SL's seat.	2.7	3.0	2.7
28. Lack of back support for the SL's seat.	2.5	3.0	2.6
29. Seat height.	2.2	3.0	2.3
30. Any difficulties with your seat during mounting or dismounting.	2.2	3.0	2.3
31. Adequacy of the radio equipment.	1.2	2.0	1.4
32. Adequacy of the intercom equipment.	1.8	1.5	1.7
33. Ability to control the activities of the driver while you were in the vehicle.	1.8	1.0	1.6
34. Ability to control the activities of the driver while you were dismounted.	1.7	0.0	1.2
35. Communication with other vehicles to coordinate targets, etc., while you were in the vehicle.	1.8	0.0	1.4
36. Communication with other vehicles to coordinate targets, etc., while you were dismounted.	2.0	0.0	1.5

Table 3 (cont'd)

	<u>INF</u>	<u>CAV</u>	<u>BOTH</u>
37. Difficulty knowing where the turret was pointed.	1.0	0.5	0.9
38. Ability to guide the gunner to a target you had located.	1.0	0.0	0.9
39. Ability to control other actions of the gunner while you were inside the vehicle.	0.3	0.0	0.3
40. Ability to control actions of the gunner while you were dismounted.	1.2	0.0	1.0
41. Difficulty with command of your squad because of delays in your ability to dismount the vehicle.	1.7	1.5	1.6
42. Difficulty with communication during mount or dismount of the vehicle.	1.5	0.0	1.3
43. Difficulty doing your job while on the move in the vehicle.	2.2	0.0	1.6
44. Difficulty getting set up rapidly to engage a target.	1.7	2.0	1.7
45. Difficulty getting set to move away from the firing area after missile impact.	2.0	2.5	2.1
46. Too little space in the Squad Leader's station.	3.0	-	-
47. Difficulty operating the radio from the SL's seat.	1.0	0.0	0.9
48. Difficulty reaching needed stored items.	2.5	2.0	2.4
49. Difficulty reaching your personal weapon in its stored position.	3.0	-	-
50. Difficulty controlling the actions of the loader from the SL's position.	0.5	0.0	0.4
51. Sharp edges or other hazards at the station (other than the turret).	2.2	0.0	1.9
52. Ability to navigate while in SL's seat.	2.8	0.0	2.4
53. Ability to move from SL's station to turret during travel.	2.5	3.0	2.6
54. Ability to determine azimuth to target at night.	2.2	1.0	1.9

Table 3 (cont'd)

	<u>INF</u>	<u>CAV</u>	<u>BOTH</u>
55. Ability to navigate and control from loader's hatch while traveling.	3.0	-	-
56. Difficulty getting comfortable while using the CVD.	2.7	-	-
57. CVD too short to be able to see while in full defilade.	3.0	-	-
58. Ability to see with the CVD when driver's hatch is open.	3.0	-	-
59. Missile Guidance set plug hitting person sitting on the SL's seat.	2.8	0.0	2.8
60. Difficulty communicating with the other vehicle in the section.	2.0	0.0	1.5
61. Overall difficulty being able to see well enough to do my job in the ITV.	3.0	2.5	2.9

c. Gunners

Human Factors Questionnaire data are presented in Table 4 for those persons who operated the ITV turret weapon systems. The most suitable summary data came from the final column of the table because squad leaders and gunners from both the infantry and the cavalry had similar experiences while using the turret. Several categories of questionnaire answers revealed important problems.

(1) Visibility. With the hatch open soldiers had clear vision to the front, but the launcher obstructed vision to the sides and rear. When buttoned up range estimation through the sights was difficult. In addition, dust, rain, mud and debris on lenses, unclear optics and fogging of the image transfer assembly (ITA) and difficulty making night sight adjustments hampered tracking. The optics had no easily used covers and were difficult to keep useably clean.

(2) Tracking. Gunners indicated some concern because of control deadband (the non-responsive center portion of control movement) and they felt it was difficult to track evasive targets. Use of the collimator and boresighting in general were viewed as problems. All persons registered concern about the inadequacy of backup turret power capability.

(3) Gunner's Seat. The seat was judged difficult to adjust and was uncomfortable in part because of no back rest.

(4) Safety. Crew members indicated difficulties and hazards getting in and out of the turret, problems of exposed wiring and hydraulic lines, and the hazard of being thrown around and hitting things (sharp edges and knobs) while underway.

(5) Machine gun. Problems noted for the machine gun were: inability to cover all areas of fire, things in the way of operation, serious over-exposure of the gunner while using the weapon, and difficulty switching from 200 to 100 round ammunition containers (required by obstructions).

(6) Other. Gunners indicated difficulties with checking the turret hydraulic pressure and with the latch on the gunner's hatch. They also were bothered by the lack of an elevation indicator on the launcher (particularly to aid in launcher stowing).

d. Drivers

Human Factors Questionnaire driver items are shown in Table 5. Most of the items rated as indicating problems related to loss in vehicle capabilities compared with the standard M113A1.

(1) Vehicle Capability. Drivers were very concerned about: vehicle power, the ability of the ITV to climb hills fast, and operate in the mud.

Table 4
SUMMARY OF MEAN RESPONSES TO THE GUNNER'S ITEMS OF THE HUMAN FACTORS QUESTIONNAIRE
ANSWERS ARE: 0 = NO PROBLEM, 1 = A MINOR PROBLEM, 2 = A MODERATE PROBLEM, AND 3 = A SERIOUS PROBLEM

HUMAN FACTORS - GUNNERS	SQUAD LEADERS						GUNNERS						SQUAD LEADERS & GUNNERS						OT IIII			DT IIII			
	OT IIII			OT IIII			OT IIII			OT IIII			DT IIII			OT IIII			DT IIII			OT IIII			
	INF	SL	CAV	SL	ALL	SL	AT	G	MECH	G	CAV	G	CAV	G	CAV	G	SL	G	SL	G	INF	CAV			
1. Getting into turret	2.3	2.0		2.2			1.5		2.0		2.0		1.6		2.0		2.0		2.0		2.0		2.0		2.0
2. Getting out of turret	2.3	2.0		2.2			1.5		2.0		2.0		1.6		2.0		2.0		2.0		2.0		2.0		2.0
3. Danger because Commander's seat is close to turret	2.5	1.5		2.2			.50		2.0		0		--		1.7		.75		1.5		1.2		1.6		1.6
4. Uncovered wires	2.5	.50		2.0			.25		2.0		2.0		.33		1.7		2.2		2.0		1.5		2.0		2.0
5. Uncovered hydraulic tubes	2.8	1.0		2.4			1.0		2.5		2.0		.92		2.2		.54		.75		.60		.56		.56
6. Hear from hydraulic accumulator and tubes	.40	1.0		.57			0		2.0		.50		.92		1.2		.58		.50		.50		.56		.56
7. The slew switch on the turret control handles	.83	0		.62			0		1.0		1.0		1.0		1.2		.58		.50		.50		.56		.56
8. Operating the hand controls to track with the ITV azimuth (left & right)	1.3	0		1.0			.75		.50		0		1.2		1.0		0		.75		.75		.75		.75
9. Operating the hand control to track with the ITV in elevation (up and down)	1.0	0		.75			0		.50		0		.67		.58		0		.44		.44		.44		.44
10. The sort of "dead band" in hand control (around center where moving control...)	1.7	1.0		1.5			1.7		2.5		2.5		2.2		1.8		1.7		1.8		1.7		1.8		1.8
11. Ability to track when the vehicle is not level	1.3	1.0		1.2			1.2		.50		.50		.42		1.2		.75		.75		.75		.75		.75
12. Confusion due to which way I had to move ITV hand control to make turret go L or R	0	0		0			.25		0		0		0		.08		0		.06		.06		.06		.06
13. Confusion due to which way I had to move the ITV hand controls to change TOW tube elevation	.17	0		.12			0		0		0		0		.08		0		0		.06		.06		.06
14. Slow speed tracking	.67	0		.50			.75		.50		0		.36		.67		0		.50		.50		.50		.50
15. Medium speed tracking	.83	1.0		.87			.75		.50		0		.45		.75		.50		.69		.69		.69		.69
16. High speed tracking	1.2	1.0		1.1			1.2		.50		.50		.64		1.1		.75		1.0		.75		1.0		1.0
17. The use of the slew switch	.50	0		.37			0		.50		.50		.75		.33		.25		.31		.25		.25		.25
18. Operating control panel switches while tracking	1.0	0		.75			.50		.50		1.5		.42		.75		.75		.75		.75		.75		.75
19. Confusion with lights on the control panel	.33	0		.25			.75		0		.50		0		.42		.25		.37		.37		.37		.37
20. Confusion because red lights indicate "warnings" as well as go conditions	1.0	0		.75			.25		0		.50		.08		.58		.25		.50		.50		.50		.50
21. Difficulty tracking because of heatwaves	1.3	0		1.0			.75		.50		0		1.6		1.0		0		.75		.75		.75		.75
22. Difficulty tracking because of dust, smoke, or haze	2.2	1.0		1.9			1.2		2.5		1.5		1.6		1.9		1.2		1.7		1.7		1.7		1.7

Table 4 (Cont'd)

HUMAN FACTORS - GUNNERS	SQUAD LEADERS						GUNNERS						SQUAD LEADERS & GUNNERS		
	OT III INF SL	OT III CAV SL	OT III ALL SL	OT III AT G	OT III MECH G	OT III CAV G	DT III G	DT III CAV G	DT III SL & G	DT III INF & CAV	SL & G INF & CAV	SL & G INF & CAV	SQUAD LEADERS & GUNNERS	SQUAD LEADERS & GUNNERS	SQUAD LEADERS & GUNNERS
23. Difficulty tracking because of vibration	2.0	0	1.5	1.0	.50	0	.50	0	.50	.67	1.4	0	.67	.50	1.1
24. Difficulty tracking because of missile fire	1.0	.50	.87	.50	0	0	0	0	.17	.42	.25	.50	.50	.62	.37
25. Difficulty tracking because of background clutter	.83	.50	.75	.0	.25	.50	.50	.42	.83	.50	.50	.75	.50	.50	.37
26. Difficulty tracking because of glare	1.3	.50	1.1	.25	.50	.50	.50	.42	.83	.50	.50	.75	.50	.50	.37
27. Difficulty tracking because of dust, mud, or debris on lenses	1.8	2.5	2.0	1.5	1.5	1.5	.50	.75	.75	1.7	1.5	1.6	1.7	1.5	1.6
28. Difficulty tracking because of rain, fog, or snow on lenses	1.5	1.5	1.5	1.5	1.5	1.5	.50	.50	—	1.5	1.0	1.4	1.7	1.0	1.6
29. Difficulty tracking because of unclear optics	1.8	1.0	1.6	1.5	2.0	1.0	.50	.75	.75	1.7	1.0	1.6	1.7	1.0	1.6
30. Difficulty making adjustments in brightness, contrast or field of view..night..	3.0	2.5	2.7	3.0	2.5	2.5	2.5	2.1	2.9	2.2	2.2	2.7	2.1	2.2	2.7
31. Difficulty setting or changing night sight focus	2.5	.50	2.0	2.0	1.5	1.5	2.0	1.4	2.2	1.2	1.2	1.9	1.7	1.2	1.9
32. Difficulty turning the night sight/tracker on and off for distance	1.3	0	1.0	.75	1.5	0	0	.70	1.2	0	0	.87	0	0	.87
33. Turning the day sight/tracker on and off	0	0	0	0	0	0	0	.17	0	0	0	0	0	0	0
34. Using the boresight collimator	3.0	0	2.2	1.5	2.5	.50	.50	1.1	2.4	.25	.25	.9	.25	.25	.9
35. Adjusting cross-hair focus	1.0	0	.75	2.5	1.5	0	.54	.83	.83	0	0	.62	.54	.54	.62
36. Switching from one sight or power to another	.50	0	.37	0	1.5	0	.08	.50	.50	0	0	.37	.50	.50	.37
37. Ability of all sight pictures to remain bore-sighted with one another	2.8	1.0	2.4	1.7	1.5	1.5	.91	2.2	1.2	2.0	2.0	2.0	.91	2.2	2.0
38. Tiring of the select and arm switch closing	.60	0	.43	.25	1.0	0	.25	.54	.54	0	0	.40	.54	0	.40
39. The gunner's hatch	.83	1.5	1.0	.75	2.0	1.5	.33	1.0	1.0	1.5	1.0	1.1	.33	1.0	1.1
40. Ability to adjust the gunner's seat	1.8	2.5	2.0	.50	1.5	.50	.50	.75	.75	1.7	1.7	2.5	.75	1.7	2.5
41. Sliding off the gunner's seat	1.7	.50	1.4	.50	1.5	.50	.50	1.5	.25	1.1	1.1	1.1	.25	1.1	1.1
42. Riding backwards in the modified seat	1.0	1.5	1.1	.75	1.0	1.5	1.5	—	—	.91	.91	1.1	.91	.91	1.1
43. Lack of back support on the seat	1.6	2.5	1.9	2.2	2.5	2.0	.80	2.0	2.0	2.2	2.2	2.1	.80	2.0	2.1
44. Place for gunner's feet when seated in the turret	1.7	1.0	1.5	1.0	1.5	.50	.17	1.4	1.4	.75	.75	1.2	.17	1.4	1.2
45. Location & accessibility of the missile guidance set	1.3	0	1.0	1.5	2.5	.50	.68	1.6	1.6	.25	.25	1.2	.68	1.6	.25

Table 4 (Cont'd)

HUMAN FACTORS - GUNNERS	SQUAD LEADERS				GUNNERS				SQUAD LEADERS & GUNNERS			
	OT III INF SL	OT III CAV SL	OT III ALL SL	OT III AT G	OT III MECH G	OT III CAV G	DR III G	DR III CAV	OT III INF	OT III SL & G	OT III CAV	OT III SL & G INF & CAV
46.	.67	0	.50	0	0	1.0	0	.67	.50	0	.37	
47.	Estimating range with the hatch open											
	(when launcher is stored)											
48.	Estimating range through the ITV sights	2.3	1.5	2.1	.75	1.0	2.0	1.0	1.6	1.7	1.6	
49.	Keeping track of "battlefield" situation through the ITV sights (launcher erect)	1.7	.50	1.4	.50	2.0	.80	1.3	1.2	1.3		
50.	Locating targets through the ITV sights (launcher erect)	1.5	0	1.1	.50	1.0	2.0	.67	1.1	1.0	1.1	
51.	Identifying targets through the ITV sights (launcher erect)	1.0	0	.75	.25	1.5	.50	.50	.83	.25	.69	
52.	Keeping track of where the launcher is aimed relative to the front of the vehicle	.67	0	.50	1.2	2.5	.50	.36	1.2	.25	.94	
53.	Knowing where to move the turret when someone else gives you a target vehicle	.50	0	.37	.75	1.0	.50	.42	.67	.25	.56	
54.	Difficulty getting fire control information from TC or others	1.0	0	.75	1.0	1.0	.50	.56	1.0	.25	.81	
55.	Confusion because of having to do several things at once	.83	0	.62	.25	1.5	0	.22	.75	'0	.56	
56.	Difficulty operating the backup hydraulic pump	3.0	1.5	2.6	2.5	3.0	3.0	2.1	.50	0	.37	
57.	Not being able to see who or what is on top of the vehicle	2.3	2.0	2.2	1.7	3.0	2.0	1.7	2.2	2.8	2.2	2.7
58.	Difficulty moving quickly to 180° in azimuth to stow the launcher	.67	0	.50	.75	2.0	2.0	.67	.92	1.0	.94	
59.	Difficulty in getting quickly to the proper elevation to stow the launcher	1.0	0	.75	1.0	1.0	2.0	1.4	1.0	1.0	1.0	
60.	Difficulty getting the launcher in position to be ready to move it to reload	.67	0	.50	.25	1.5	.50	.33	.67	.25	.56	
61.	Blind spots when the launcher is stowed	1.7	.50	1.4	1.2	3.0	1.5	1.2	1.7	1.0	1.6	
62.	Things that could jam the turret on the outside of the vehicle	1.5	.50	1.2	.75	2.0	.50	1.0	1.3	.50	1.1	
63.	Adequacy of space in the turret (head room, leg room, shoulder room, etc.)	2.0	1.0	1.7	1.5	1.5	.50	1.2	1.7	.75	1.5	

Table 4 (Cont'd)

HUMAN FACTORS - GUNNERS	SQUAD LEADERS						GUNNERS						SQUAD LEADERS & GUNNERS					
	OT III INF SL	OT III CAV SL	OT III ALL SL	AT G	MECH G	G	OT III CAV G	OT III G	DT III G	OT III SL & G	OT III INF	DT III CAV	OT III SL & G	OT III INF	DT III CAV	OT III SL & G	OT III INF & CAV	
64. Sharp edges or knobs in the turret	1.8	2.5	2.0	1.2	2.5	1.0	.67											
65. Hazards you bumped into when entering or leaving the turret	1.8	2.0	1.9	1.5	2.0	2.0	1.7	1.7	1.7	2.0	1.8							
66. Height and location of the ITV control panel	1.0	0	.75	.75	0	.50	.42	.75	.25									
67. Lack of an elevation indicator	2.2	0	1.6	1.0	2.5	2.0	2.1											
68. Difficulty operating the turret in the dark	1.0	0	.75	.75	1.5	.50	.30	1.0										
69. Difficulty finding things in the dark	1.7	1.0	1.5	1.5	1.0	1.5	.1.2											
70. Mud being thrown on you, the sights or weapons when vehicle is on the move	1.8	2.5	2.0	1.3	1.5	.50												
71. Operation of machinegun	2.2	0	1.6	.33	2.5	0												
72. Things in the way of operating the machinegun	3.0	0	2.1	1.0	1.5	1.0												
73. Inability to cover the necessary area with the machinegun	2.8	0	2.1	1.7	2.5	0												
74. Brass from the machinegun getting in the way (e.g. under foot)	2.2	1.0	1.9	.50	.50	0												
75. Difficulty hearing/communicating with TC or others	1.2	0	.87	1.3	2.0	.50												
76. Standing on the gunner's seat during travel	1.5	0	1.1	1.3	2.0	1.0												
77. Being too high in the hatch while standing on the gunner's seat	1.7	1.5	1.6	1.0	1.5	1.5												
78. Being thrown around & hitting things (e.g. hatch cover...) while standing on...	2.3	3.0	2.5	1.0	2.0	2.0												
79. Exposure while firing the machinegun	2.5	0	1.9	—	2.0	.50												
80. Difficulty loading & reloading the machinegun (e.g. using 100 & 200 round boxes)	2.6	0	1.9	—	2.5	0												
81. Putting the machinegun into operation or stowing it.	1.2	0	.87	—	2.5	0												
82. Ammunition box getting in the way	2.6	0	1.9	—	1.5	.50												
83. Difficulty determining vehicle angle to avoid getting a fire interrupt	1.0	0	.75	.33	2.0	.50												
84. Lack of handle on the night sight cover	1.2	0	.87	0	2.5	1.0												

Table 4 (Cont'd)

HUMAN FACTORS - GUNNERS	SQUAD LEADERS						GUNNERS						SQUAD LEADERS & GUNNERS					
	OT III INF SL	OT III CAV SL	OT III ALL SL	OT III AT G	OT III MECH G	OT III CAV G	DT III G	DT III CAV G	OT III SL & C	OT III INF	OT III CAV	OT III SL & C	OT III INF	OT III CAV	OT III SL & C	OT III INF & CAV		
85. Activator switches on the tracking hand control difficult to hold	.50	0	.37	.33	2.0	1.5	.73	.75	.73	.73	.73	.73	.73	.73	.73	.73	.73	
86. Difficulty checking the hydraulic level	2.0	1.5	1.9	1.3	2.5	3.0												
87. Difficulty with fogging in the image transfer assembly																		
88. Gunner check lists too long & too slow a process	2.2	1.5	2.0	1.0	2.5	1.5												
89. Difficulty with the latch on the gunner's hatch	1.0	1.0	.33	1.5	.50													
90. Difficulty tracking evasive targets that suddenly changed direction	1.2	2.0	1.4	1.7	2.0	2.0												
91. Difficulty staying on target when the accumulator pressure motor is on																		
92. Difficulty seeing when launcher is stowed & the vehicle is buttoned up	1.4	.50	1.1	0	1.5	.50												
93. Difficulty seeing the azimuth ring at night	.50	2.0	1.7	3.0	2.5													
94. Difficulty reading the azimuth ring because the pointer is off on the right side	.83	0	.62	.67	2.5	0												
95. Difficulty installing or removing sights	1.7	0	1.2	.33	1.0	.50												
96. Difficulty installing or removing collimator	2.3	0	1.7	1.3	2.0	.50												
97. Lack of covers for all sights	2.3	0	1.7	.67	3.0	.50												
98. Difficulty of keeping lenses clean	2.3	1.5	2.1	.67	2.5	.50												
99. Lack of scribe lines to help estimate range	2.5	1.5	2.2	1.7	2.0	1.0												
100. The field of view in the low power sight not being wide enough	2.0	2.5	2.1	1.7	1.7	1.0												
101. Boresight adjustments too sensitive & hard to set	1.0	0	.75	1.0	1.0	1.0												
	2.3	0	1.7	.67	1.5	1.5												

Table 5

Summary of Mean Responses to the Driver's Items of the Human Factors Questionnaire. Answers are: 0 = No Problem, 1 = A Minor Problem, 2 = A Moderate Problem, and 3 = A Serious Problem

	<u>INF</u>	<u>CAV</u>	<u>BOTH</u>
1. Difficulty steering the vehicle.	1.2	2.0	1.4
2. Difficulty with the operation of the accelerator.	1.0	0.0	0.7
3. Transmission shifting too slowly.	1.5	0.5	1.2
4. Any other difficulty with operation of the transmission.	1.2	0.0	0.9
5. Difficulty with the operation of the brakes.	1.0	0.5	0.9
6. Difficulty with track replacement.	1.0	0.5	0.9
7. Difficulty reading any visual display.	0.2	0.5	0.2
8. Difficulty operating any other controls.	0.7	0.5	0.6
9. Adequacy of storage in the driving compartment.	1.7	1.0	1.5
10. Vision in daylight when the hatch was open.	0.3	0.0	0.2
11. Vision at night when the hatch was open.	0.5	0.0	0.4
12. Vision through the periscopes in daylight when "buttoned up".	1.2	1.0	1.1
13. Difficulty seeing through the periscopes because of the sun's glare.	1.5	2.0	1.6
14. Vision through the periscopes at night when "buttoned up".	2.2	2.0	2.1
15. Vision during bad weather when the hatch was open.	1.0	1.5	1.1
16. Vision during bad weather when "buttoned up".	2.2	2.5	2.2
17. Difficulty seeing with the blackout lights.	1.5	1.5	1.5
18. Difficulty seeing with the headlights.	0.5	0.0	0.4

Table 5 (cont'd)

	<u>INF</u>	<u>CAV</u>	<u>BOTH</u>
19. Any other obstructions to vision.	0.2	0.0	0.7
20. Adequacy of mud flaps.	1.0	0.0	0.7
21. The lack of a windshield.	1.4	0.5	1.1
22. Getting gas in the "bilge" during refueling.	0.3	0.0	0.2
23. Weapon(s) being fired near your hatch.	1.3	0.5	1.1
24. Difficulty knowing where the main gunner's weapon(s) were pointed relative to the front of the vehicle.	1.0	0.0	0.7
25. Difficulty coordinating with the gunner when the track commander was dismounted.	0.7	0.0	0.5
26. Difficulty coordinating with the track commander.	0.5	0.0	0.4
27. Adequacy of the night vision equipment.	0.5	0.5	0.5
28. Difficulties with the driver's hatch.	1.7	1.5	1.6
29. Too little space in the driver's compartment.	1.8	1.5	1.7
30. Difficulty reaching tools, grease gun, or personal items.	1.7	1.0	1.5
31. Difficulty reaching intercom controls.	0.8	0.0	0.6
32. Difficulty seeing all instruments in some driving positions.	1.3	0.0	1.0
33. Difficulty reaching things while working in the engine compartment.	1.8	1.0	1.6
34. Not enough power to climb hills fast.	3.0	2.5	2.9
35. Not enough power for use in mud.	2.2	3.0	2.4
36. Difficulty because of the higher center of gravity of the ITV compared with the M113A1.	2.0	2.5	2.1
37. Difficulty because of a loss in mobility of the ITV compared with the M113A1.	2.3	2.2	2.2

Table 5 (cont'd)

		<u>INF</u>	<u>CAV</u>	<u>BOTH</u>
38.	Difficulty because of a loss in power of the ITV compared with the M113A1.	2.8	0.5	2.2
39.	Difficulty because of a loss in acceleration of the ITV compared with the M113A1,	2.5	0.5	2.0
40.	Difficulty moving the ITV with the launcher erect.	2.7	2.5	2.6
41.	Difficulty driving the ITV with the launcher in high stow,	1.0	0.0	0.7
42.	Difficulty getting the vehicle level enough for use of the ITV launcher.	1.2	0.0	0.9
43.	Adequacy of the pitch and cant indications in the driver's compartment,	1.2	0.0	0.9
44.	Difficulty using the night vision goggles when in the "pop-hatch" mode.	2.3	1.5	2.1
45.	Loss of traction on hills.	2.7	2.5	2.6
46.	Problems climbing hills at an angle because of concern about the ITV having a higher center of gravity.	2.7	2.5	2.6
47.	Difficulty hearing or understanding instructions from the TC.	0.8	1.5	1.0
48.	Difficulties with the intercom system.	2.0	1.5	1.9

They saw the rise in center of gravity as a problem as were the loss of power, traction, acceleration, and mobility (compared with the M113A1).

(2) Driver's Hatch. There were difficulties with the driver's hatch including problems using night vision goggles when in the pop-hatch mode.

e. Loaders

Loader's items from the Human Factors Questionnaire are given in Table 6. The main problems indicated were: headset cords (not long enough or in the way while loading missiles or doing other jobs), sharp edges in the work area, inability to see out enough and difficulty throwing missile casing out of vehicle. There were problems relating to the observer mission but these will be covered in the section on interview results.

Table 6

Summary Of Mean Responses To Loaders Items For The Human Factors Questionnaire. Answers Are: 0 = No Problem, 1 = A Minor Problem, 2 = A Moderate Problem, and 3 = A Serious Problem

	<u>INF</u>	<u>CAV</u>	<u>BOTH</u>
1. Adequacy of my seat.	0.8	1.5	1.0
2. Not knowing where you are because of inability to see out of the vehicle enough.	2.3	2.0	2 2
3. Sharp edges in the area where you have to operate.	1.7	2.0	1.7
4. Difficulty coordinating with the track commander.	1.2	1.0	1.1
5. Difficulty coordinating with the gunner.	1.3	1.1	1.2
6. Ability to hear commands.	1.2	1.0	1.1
7. Ability to see squad leader signals from your seat in the vehicle.	0.5	1.0	0.6
8. Noise in the vehicle during live firing.	0.8	1.5	1.0
9. Cargo hatch not latching high enough so that I can load missiles easily.	1.0	1.5	1.1
10. Difficulty with the missile latch system so I can't be sure the missile is loaded properly.	1.0	2.0	1.2
11. Awkwardness of loading the ITV from inside the vehicle.	1.2	2.5	1.5
12. Difficulty holding the weight of missiles at the angle required for loading.	1.0	1.2	1.1
13. Difficulty loading missiles when the ITV isn't level.	1.4	1.5	1.4
14. Headset cords in the way while loading missiles.	2.7	2.5	2.6
15. Headset cords in the way doing other jobs.	2.2	2.0	2.1
16. Difficulty throwing missile casings out the right side of the ITV.	1.0	1.5	1.1
17. Difficulty throwing missile casings out the left side of the ITV.	2.2	2.0	2.1

Table 6 (cont'd)

	<u>INF</u>	<u>CAV</u>	<u>BOTH</u>
18. Difficulty using the intercom box in it's present location.	1.3	2.0	1.5
19. The headset cord not being long enough to reach where I had to go.	2.2	1.2	1.9
20. Difficulty with the missile load rails.	1.2	2.0	1.4
21. Damage to things while throwing missile casings away.	1.2	0.5	1.0
22. Machine gun butt clamp getting in the way or getting damaged by cargo hatch.			

QUALITY OF DESIGN/REDESIGN REQUIREMENTS QUESTIONNAIRE

The quality of design ratings gave crew members the chance to indicate pieces of equipment or design features that were excellent at one extreme or serious problems needing change or improvement at the other extreme. Items rated in the serious problem range (average of 3.6 or higher) should receive redesign attention and so are highlighted here. Squad leaders and gunners were most aware of changes needed. Their data will be emphasized. As in most of the results, DT III data from Phase A are available but these soldiers never saw or used ITVs which contained the latest modifications. Their data, therefore, won't be included in this summary. See Table 7 for data details for the findings summarized below.

a. Squad Leader's Station

The squad leader's seat and the CVD were both seen as requiring redesign. The seat should have a back and be spring loaded to fold away to permit easy entrance and exit especially by the driver. The general feeling about the CVD is that although the device concept is good the CVD has too many limitations. It is not responsive to the squad leader's mission needs.

b. Gunner's Station

The most criticized things in the turret related to the viewing system - most specifically boresighting and night sight adjustments, and the excessive use of nitrogen bottles. The image transfer assembly (ITA) was seen as a problematic part of the optical system. Worst of all was the rating of the turret backup power system - seen as definitely needing redesign.

c. Vehicle Limitations

Crew members were sufficiently concerned about hill climbing, speed, power, and maneuverability that they are among the features of the ITV called serious problems that should be changed.

d. Secondary Armament

Soldiers did not like the limitation that required loading a 100 round ammunition box (rather than 200) into the M60 machine gun whenever the TOW launcher is to be used. This coupled with the difficulty in being able to fire small arms from the ITV appear to limit seriously the crew's ability to suppress personnel and/or to defend the vehicle if that should become necessary.

Summary of Means Ratings of Quality of Design of The ITV System For
Different Groupings of Respondents. Answers Are: 1 = Excellent as is -
I like it, 2 = Acceptable as is - I would use it as is, 3 = Moderate
problem - change would be helpful, but not required, 4 = Serious problem -
item should be changed/improved before production, and 5 = Very serious
problem - Item must be changed/improved before production

Table 7

QUALITY OF DESIGN	SQUAD LEADERS						GUNNERS						SQUAD LEADERS & GUNNERS						TOTALS			
	OT III			OT III OT III			OT III OT III OT III			DT III			OT III OT III OT III			All CREW			All PERS		All PERS	
	INF SL	CAV SL	ALL SL	AT G	MCR G	CAV G	G	SL & G	SL & G	SL & G	N=12	N=4	N=16	N=33	N=44	N=77	OTHER PERS	All PERS				
1. Gunner's seat.	2.7	3.0	2.7	3.2	3.5	3.0	2.4	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	2.6	2.6	2.8	2.8
2. Gunner's hatch.	2.5	3.0	2.6	2.7	4.0	3.0	1.8	2.8	3.0	3.0	2.9	3.0	2.9	2.7	2.7	2.7	2.7	2.7	2.3	2.3	2.5	2.5
3. Driver's seat.	1.7	1.5	1.6	1.7	-	1.5	-	1.7	-	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.9	1.9	1.9	1.9
4. Driver's hatch.	3.5	4.0	3.6	3.0	4.0	4.0	-	4.0	-	3.3	4.0	3.5	3.5	3.5	3.5	3.5	3.5	3.5	2.9	2.9	2.9	2.9
5. Commander's seat.	4.0	4.0	4.0	3.2	4.5	3.0	-	3.8	-	3.5	3.5	3.8	3.8	3.7	3.7	3.7	3.7	3.7	2.9	2.9	3.3	3.3
6. Gunner's control locations.	2.3	1.5	2.1	2.0	2.5	1.5	-	2.2	-	2.2	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	1.8	1.8	2.0	2.0
7. Gunner's control "feel".	2.5	2.0	2.4	2.2	2.5	2.0	3.0	2.4	2.0	2.4	2.0	2.4	2.0	2.4	2.0	2.4	2.4	2.4	1.9	1.9	2.2	2.2
8. Deadband in gunner's control.	2.8	2.5	2.7	3.5	3.5	3.5	-	3.2	3.0	3.1	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	2.7	2.7	2.7	2.7
9. Someone else's seat/station blocks gunner.	2.8	2.5	2.7	2.5	2.5	2.0	2.3	2.6	2.2	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.7	2.7	2.7	2.7
10. Placement of comms/radio gear.	2.7	3.0	2.7	2.7	3.0	2.0	2.0	1.7	2.0	2.6	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.3	2.3	2.5	2.5
11. Placement of wiring.	3.3	2.0	3.0	2.5	-	2.0	2.2	2.9	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	3.2	3.2	2.9	2.9
12. Ruggedness of wiring and hydraulics.	3.7	2.5	3.4	3.0	-	2.0	2.4	3.5	2.0	2.4	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.1	3.1	3.1	3.1
13. Exposed hydraulic lines.	3.7	2.5	3.4	3.5	4.0	4.0	-	3.7	3.2	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.4	3.4	3.4	3.4	3.4
14. Proximity switches on hatches.	2.5	2.5	2.5	2.5	4.0	2.5	-	2.7	2.5	2.5	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.5	2.5	2.6	2.6
15. Usefulness of intercom equipment.	2.0	2.5	2.1	2.7	4.0	2.0	1.7	2.6	2.0	2.6	2.2	2.2	2.5	2.5	2.5	2.5	2.5	2.5	2.1	2.1	2.4	2.4
16. Bottomed up visibility (Gunner's station).	2.3	2.5	3.1	3.0	4.0	3.0	2.4	3.3	2.4	3.3	2.7	3.2	3.2	3.0	3.0	3.0	3.0	3.0	2.2	2.2	2.6	2.6
17. Bore sighting procedures.	3.5	2.0	3.1	3.2	3.5	2.0	2.8	3.4	2.0	3.4	2.0	3.4	3.4	3.4	3.4	3.4	3.4	3.4	2.7	2.7	2.9	2.9
18. Frequency that bore sighting is required.	4.7	2.5	4.1	4.2	5.0	4.0	-	4.6	3.2	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	3.9	3.9	3.0	3.5	3.5
19. Sharp equipment edges.	3.7	3.5	3.6	2.7	3.0	2.0	2.7	3.2	2.0	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	3.2	3.2	3.2	3.0	3.0
20. Ease of raising launcher.	2.0	3.5	2.4	2.5	2.0	2.0	-	2.2	2.2	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.4	2.4	2.1	2.1	2.1
21. Ease of stowing launcher.	2.0	3.5	2.4	2.5	2.0	3.5	-	2.2	3.5	2.5	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.5	2.5	2.4	2.4	2.4
22. Ease of putting launcher in reload position.	2.0	3.0	2.2	2.5	2.0	2.0	-	2.2	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.9	1.9	2.0	2.0	2.0
23. Light displays for launcher control.	1.8	2.0	1.9	2.7	2.5	1.5	-	2.2	1.5	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.1	2.1	2.1	2.1
24. Machinegun stow.	2.0	2.5	2.1	2.2	4.0	2.0	-	2.2	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.7	2.7	2.8	2.8

Table 7 (Cont'd)

QUALITY OF DESIGN	SQUAD LEADERS						GUNNERS						SQUAD LEADERS & GUNNERS						TOTALS	
	OT III INF SL	OT III CAV SL	OT III ALL SL	OT III AT G	OT III MECH G	DT III CAV G	OT III CAV G	DT III CAV G	OT III SL & C	OT III SL & C	ALL OT III SL & C	OTHER OT III PERS	ALL OT III CAV CREW	TOTALS INF	ALL OT III CAV CREW					
25. Turret fits ITV hull	3.5	2.5	3.2	2.5	3.0	2.0	1.8	2.2	2.2	2.5	2.5	2.1	2.1	2.5	2.1	2.1	2.3	2.1	2.3	
26. Launcher has enough clearance outside	2.5	2.5	2.5	2.5	3.0	2.0	1.7	2.6	2.2	2.5	2.5	2.1	2.1	2.5	2.1	2.1	2.3	2.1	2.3	
27. Gunner's Station...clearance inside ITV	3.2	2.5	3.0	3.0	3.0	2.0	2.3	3.1	2.2	2.9	2.9	2.5	2.5	2.7	2.5	2.5	2.7	2.5	2.7	
28. Room with basic personal equipment on	4.3	4.0	4.2	4.0	3.5	4.5	2.6	4.1	4.2	4.1	4.0	3.3	3.3	3.7	3.3	3.3	3.7	3.3	3.7	
29. Room when wearing Web gear & winter clothes	4.3	4.0	4.2	4.0	5.0	4.5	—	4.3	4.2	4.3	4.2	3.4	3.4	3.9	3.4	3.4	3.9	3.4	3.9	
30. Driver visibility buttoned up	2.7	2.5	2.6	3.0	—	2.0	2.3	2.7	2.2	2.6	2.6	2.4	2.4	2.6	2.4	2.4	2.6	2.4	2.6	
31. Commander's viewing device (GVD)	4.5	—	4.5	3.3	4.5	—	—	4.2	—	4.1	3.8	3.5	3.5	3.1	3.8	3.5	3.1	3.8	3.1	
32. Equipment storage space	4.3	4.0	4.2	4.0	4.0	4.0	2.3	4.2	4.0	4.0	4.0	3.4	3.4	3.7	3.4	3.4	3.7	3.4	3.7	
33. Center of gravity of ITV	3.2	3.5	3.3	3.0	—	3.0	—	3.1	3.2	3.1	3.1	2.8	2.8	3.1	3.1	3.1	3.1	3.1	3.1	
34. Space to perform job	4.0	2.5	3.6	3.2	2.5	3.0	2.3	3.5	2.7	3.3	3.3	3.0	3.0	3.1	3.0	3.0	3.1	3.0	3.1	
35. Power of ITV	4.2	4.0	4.1	3.7	4.0	2.5	—	4.0	3.2	3.8	3.8	3.1	3.1	3.5	3.2	3.1	3.1	3.2	3.1	
36. Roll climbing of ITV	4.3	4.0	4.2	4.0	4.5	4.5	4.0	—	4.2	4.0	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	
37. Maneuverability of ITV	3.5	4.5	3.7	3.5	3.5	3.0	1.9	3.4	4.0	3.6	3.6	2.4	2.4	3.0	3.6	3.6	2.4	3.0	3.0	
38. Speed of ITV	4.0	4.0	4.0	3.7	4.5	3.5	2.1	4.0	3.7	4.0	3.7	3.1	3.1	3.1	3.7	3.7	3.1	3.1	3.1	
39. Seats in crew compartment	3.8	3.0	3.6	3.0	3.0	3.0	2.4	3.4	3.0	3.0	3.0	3.2	3.2	3.1	3.0	3.0	3.2	3.0	3.1	
40. Headgear in ITV	2.7	2.5	2.6	2.5	2.5	2.5	1.7	2.6	2.5	2.6	2.5	2.4	2.4	2.5	2.6	2.5	2.4	2.5	2.5	
41. Engine access (from outside the ITV)	2.5	2.5	2.5	2.5	2.7	2.5	2.0	2.1	2.6	2.2	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	
42. Engine access (from inside)	2.2	2.5	2.2	2.2	2.7	3.0	1.9	2.7	2.7	2.7	2.7	2.4	2.4	2.4	2.5	2.5	2.4	2.4	2.4	
43. Launcher loading mechanisms	3.0	2.5	2.9	2.7	—	2.5	2.2	2.5	2.2	2.5	2.5	2.8	2.7	2.7	2.5	2.5	2.6	2.5	2.6	
44. TOW missile stowage racks	2.7	2.5	2.6	2.5	2.5	2.5	2.5	2.2	2.6	2.5	2.6	2.6	2.6	2.5	2.6	2.5	2.6	2.5	2.5	
45. TOW ground mount equipment storage	2.3	—	2.4	2.2	3.0	—	1.7	2.4	—	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	
46. Small arms storage	3.8	4.5	4.0	2.5	3.5	4.0	2.2	3.3	4.2	3.6	3.6	3.0	3.0	3.0	3.6	3.6	3.0	3.0	3.0	
47. Heater	2.8	2.5	2.7	3.5	2.5	2.0	2.0	3.0	2.0	2.2	2.2	2.7	2.7	2.7	2.5	2.5	2.6	2.5	2.6	
48. Cargo hatch	2.5	2.5	2.5	2.2	3.0	2.5	—	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.4	2.5	2.4	
49. Rear ramp	1.8	2.0	1.9	2.2	2.0	2.0	1.7	2.0	2.0	1.7	2.0	2.0	2.0	2.0	2.0	2.0	1.7	1.7	1.7	
50. Wheel blocks	2.5	2.5	2.5	2.5	2.5	2.5	2.0	2.6	2.5	2.5	2.5	2.4	2.4	2.4	2.5	2.5	2.4	2.4	2.4	
51. Night Vision capability	3.8	2.0	3.4	3.5	3.0	2.0	3.2	3.6	2.0	3.2	3.2	2.9	2.9	2.9	2.7	2.7	2.8	2.7	2.7	
52. Batteries for night sight	2.7	2.5	2.6	3.0	2.5	2.5	2.5	—	2.7	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	
53. Bottles for night sight	3.3	4.0	3.5	4.0	3.5	4.0	3.5	—	3.5	3.7	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	
54. Daylight sights	2.2	2.5	2.2	1.5	2.0	1.5	1.5	1.5	1.5	1.9	1.9	1.9	1.9	1.9	1.9	1.9	2.0	2.0	2.0	
55. Protection for sights	3.7	3.5	3.6	3.0	3.5	2.0	3.5	2.7	3.4	3.4	3.4	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	

Table 7 (Cont'd)

QUALITY OF DESIGN	SQUAD LEADERS						GUNNERS						SQUAD LEADERS & GUNNERS						TOTALS					
	OT III	OT III	OT III	OT III	AT G	ALL SL	INF SL	CAV SL	MECH G	CAV G	DT III	OT III	OT III	OT III	SL & C	SL & C	SL & C	INP & CAV	INP & CAV	ALL PERS	OTHER PERS	ALL CREW	OT III PERS	OT III CREW
56. Night sight controls	4.5	3.5	4.2	4.2	4.0	3.0	—	—	—	—	4.3	3.2	4.1	3.9	3.7	3.8	—	—	—	—	—	—	—	—
57. Day sight controls	2.2	2.0	2.1	2.5	2.0	2.5	—	—	—	—	2.2	1.7	2.1	2.3	2.6	2.5	—	—	—	—	—	—	—	—
58. Cover lid on top of sights	3.2	2.5	3.0	2.2	3.0	2.5	—	—	—	—	2.8	2.5	2.8	2.6	2.6	2.3	2.4	—	—	—	—	—	—	—
59. Sturdiness of erection mechanism	2.8	3.5	3.0	3.2	2.5	3.0	2.3	2.3	2.3	2.3	2.9	3.2	3.0	3.0	3.0	2.5	2.8	—	—	—	—	—	—	—
60. Reliability of erection mechanism	3.3	3.5	3.4	3.0	3.0	3.0	2.2	2.2	2.2	2.2	3.2	3.2	3.2	3.2	3.2	3.1	2.8	3.0	—	—	—	—	—	—
61. Gunner's station blocks other crew members	2.8	2.5	2.7	2.7	2.5	2.5	—	—	—	—	2.7	2.2	2.2	2.7	2.7	2.6	2.3	2.5	—	—	—	—	—	—
62. Seat backs	3.2	3.0	3.1	3.7	3.1	3.7	—	—	—	—	3.4	2.5	2.5	2.5	2.5	3.3	3.3	2.9	—	—	—	—	—	—
63. Seat restraints	2.2	2.0	2.1	3.2	3.5	2.0	—	—	—	—	1.9	2.0	2.0	2.0	2.0	2.6	2.7	2.4	2.6	2.6	2.6	2.6	2.6	2.6
64. Track tension after extended use	2.7	2.5	2.6	2.3	—	—	2.0	2.0	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.5	2.6	—	—	—	—	—	—	—
65. Suspension of the vehicle	3.0	2.5	2.9	2.3	—	—	2.5	2.5	2.8	2.8	2.5	2.5	2.5	2.5	2.5	2.7	2.8	—	—	—	—	—	—	—
66. Ventilation	3.5	2.5	3.2	2.5	3.0	2.0	2.4	2.4	3.0	3.0	2.4	2.4	2.4	2.4	2.4	2.8	2.8	—	—	—	—	—	—	—
67. Ability to use small arms from inside the vehicle	4.2	4.0	4.1	4.3	5.0	5.0	—	—	—	—	4.0	4.4	4.4	4.4	4.4	4.1	4.1	4.0	4.0	4.0	4.0	4.0	4.0	4.0
68. Ability to use machinegun from gunner's station	3.7	2.0	3.2	3.0	3.5	2.0	2.0	2.0	2.0	2.0	3.5	2.0	2.0	2.0	2.0	3.1	2.9	2.8	2.8	2.8	2.8	2.8	2.8	2.8
69. Inability to keep 200 rd amo box...when turret is in use	4.4	2.5	3.9	3.5	3.5	4.0	—	—	—	—	3.9	3.2	3.7	3.9	3.7	3.8	—	—	—	—	—	—	—	—
70. Safety padding	3.2	2.5	3.0	2.7	—	—	—	—	—	—	3.0	2.7	3.0	3.1	3.4	3.0	3.4	3.0	3.2	3.0	3.2	3.0	3.2	3.0
71. ITV brakes	2.7	3.0	2.7	2.2	3.5	2.0	2.0	2.0	2.0	2.0	2.7	2.0	2.0	2.0	2.0	2.6	2.6	2.6	2.0	2.3	2.0	2.3	2.0	2.3
72. Driver controls	2.0	2.0	1.7	1.7	—	—	2.0	1.8	1.8	1.8	2.0	1.9	2.0	1.9	2.0	1.9	2.1	2.1	1.8	2.0	1.8	2.0	1.8	2.0
73. Space large enough for large man	3.7	2.5	3.4	3.7	—	—	—	3.5	3.2	3.7	3.0	3.5	3.0	3.5	3.5	3.1	3.1	3.4	—	—	—	—	—	—
74. Small man as loader	3.2	—	2.9	3.2	—	—	—	1.5	3.4	3.4	1.3	2.1	1.7	2.0	2.0	2.7	2.7	2.2	2.5	2.5	2.0	1.8	1.9	2.0
75. Small man as gunner	2.2	—	2.0	2.2	—	—	2.0	2.2	2.0	2.0	1.8	2.1	2.1	2.1	2.1	2.0	2.0	2.0	1.8	1.9	1.9	1.9	1.9	1.9
76. Refueling system	1.7	2.0	1.7	2.5	1.5	—	—	2.0	1.5	1.5	2.0	1.9	2.0	1.9	2.0	1.9	2.0	2.0	—	—	—	—	—	—
77. Ability to add & move an injured crew member	3.4	2.5	3.1	3.7	2.5	—	—	2.7	3.7	3.7	2.3	2.7	2.7	2.7	2.7	3.1	3.1	2.8	2.8	2.8	2.8	2.8	2.8	2.8
78. Places where rain water leaks in	3.8	2.5	3.5	2.5	3.5	—	—	3.2	3.3	3.3	2.3	3.2	3.1	3.2	3.2	—	—	—	—	—	—	—	—	—
79. Large man as loader	3.7	—	3.7	1.7	—	—	—	—	—	—	1.5	2.7	—	—	—	2.9	3.1	2.6	2.6	2.6	2.6	2.6	2.6	2.6
80. Large man as gunner	4.0	—	4.0	3.2	—	—	—	—	—	—	3.2	3.7	—	—	—	3.6	3.5	3.4	3.5	3.5	3.4	3.5	3.5	3.5
81. Personal gear placement in/on vehicle	4.5	4.0	4.4	4.0	4.0	—	—	—	—	—	4.0	4.4	4.4	4.4	4.4	4.2	3.7	4.1	4.1	4.1	4.1	4.1	4.1	4.1

Table 7 (Cont'd)

QUALITY OF DESIGN	SQUAD LEADERS				GUNNERS				SQUAD LEADERS & GUNNERS				TOTALS			
	OT III INF SL	OT III CAV SL	OT III ALL SL	OT III AT C	OT III MECH G	OT III CAV G	DT III G	OT III SL & G	OT III INF	OT III CAV	OT III SL & G	OT III INF	OT III CAV CREW	ALL PERS	OTHER PERS	ALL PERS
82. Amount of power to drive ITV turret	2.8	3.5	3.0	3.2	3.0	—	—	3.0	3.0	3.0	3.0	3.0	3.0	2.6	2.6	2.8
83. Lighting inside the ITV	2.8	4.0	3.1	2.5	3.0	—	—	2.7	3.3	2.9	2.8	2.8	2.4	2.4	2.6	2.6
84. Image transfer assembly (ITA)	4.2	3.5	4.0	3.2	3.5	—	—	3.7	3.0	3.6	3.3	3.2	3.2	3.3	3.3	3.3
85. Backup power (s tracking)	5.2	3.0	4.6	4.2	5.0	—	—	4.8	3.7	4.6	4.6	4.6	4.6	4.0	4.0	4.0
86. Design for operation in ice & snow	3.3	3.5	3.4	3.2	3.0	—	—	3.2	3.0	3.2	3.2	3.2	3.2	2.8	2.8	3.0
87. Design for operation in rain & mud	3.2	4.0	3.4	3.2	3.0	—	—	3.2	3.3	3.2	3.2	3.2	3.2	2.7	2.7	3.0
88. Design for operation in dust & dirt	3.3	3.0	3.2	3.0	3.5	—	—	3.2	2.7	3.1	3.1	3.1	3.1	2.8	2.8	3.0
89. Ability to eat range when buttoned up	4.0	2.5	3.6	3.0	—	—	—	3.5	2.7	3.3	3.2	3.2	3.2	—	—	3.0
90. Knowing elevation of launcher	4.0	2.0	3.5	4.0	—	—	—	3.8	2.0	3.5	3.3	3.3	3.3	3.2	3.2	3.2
91. Azimuth indicator	2.7	2.0	2.5	2.2	2.0	—	—	2.4	2.0	2.3	2.4	2.4	2.4	2.2	2.2	2.3
92. Frequency of required vehicle battery charges	3.3	2.0	3.0	2.5	3.0	—	—	3.0	2.0	2.8	3.0	3.0	3.0	2.9	2.9	2.9
93. High profile of ITV	3.7	2.5	3.4	3.5	3.0	—	—	3.5	2.3	3.3	3.2	3.2	3.2	2.7	2.7	3.0
94. Circuit breakers	2.5	2.5	2.5	2.7	2.0	—	—	2.4	2.3	2.4	2.4	2.4	2.4	2.3	2.3	2.4
95. Possibility of damage to missile guidance set (M55)	3.3	2.5	3.1	3.0	—	—	—	3.2	2.3	3.0	3.0	3.0	3.0	3.1	3.1	3.1
96. Fire interrupts	2.5	2.0	2.4	2.2	2.5	—	—	2.4	2.0	2.3	2.3	2.3	2.3	2.6	2.6	2.6
97. Communications wire & holder outside vehicle	2.8	2.0	2.6	2.2	—	—	—	2.6	2.0	2.5	2.5	2.5	2.5	2.2	2.2	2.4
98. Ability to camouflage ITV	4.5	—	4.3	4.2	3.5	—	—	4.2	—	4.0	4.0	4.0	4.0	2.6	2.6	2.6
99. Small man as observer	1.8	—	1.7	2.2	—	—	—	2.1	—	1.9	1.9	1.9	1.9	2.0	2.0	2.0
100. Large man as observer	3.7	—	3.7	—	—	—	—	3.0	—	3.1	3.1	3.1	3.1	3.0	3.0	3.2

e. Space and Storage

Recognizing the crowdedness of vehicles like the ITV, in this report little attention has been given to crew member's repeated complaints in these areas. It is a fact, however, that they gave poor ratings to conditions such as space to operate while wearing winter clothing - but even when wearing normal personal gear. The personal storage situation (clothing, etc.) is also rated as serious and probably should receive attention.

INTERVIEW SUMMARY

What follows is a summary of the main points and suggestions gathered from Post - OT III interviews with infantry and cavalry ITV crew members.

a. Squad Leader Comments

(1) Command and Control. The squad leader must control the crew activities and he may coordinate those of a second ITV crew as well. His duty station is not designed to facilitate his command functions. In combat he will be buttoned up and relying on the Commanders Viewing Device (CVD) to detect, identify, and prioritize targets for the gunner to acquire and engage.

At OT III, Phase B, squad leaders responded that if this station was necessary, the seat should be reversed placing the seat back against that of the driver. The CVD was of limited use and gunner's station had to be used to navigate. The seat is too close to the turret and causes a hazard to the squad leader and to the turret operation. Gear can get caught on and under the rotating turret easily. The seat also blocks access between the crew and driver compartments. The squad leaders felt that other crewmen had to make up for the degradation in the squad leaders' ability to maintain command and control.

(2) Seat reversal. If the squad leader faced the crew compartment and had a folding seat he would have less difficulty controlling his crew during target engagements. He would have eye contact with his gunner and loader to augment verbal communication. The squad leader would have easier access to the vehicle radios as well. Further details are given in a memo regarding seat reversal (see Appendix B).

(3) Commander's Viewing Device (CVD). The CVD is considered less than adequate by the test personnel asked to use it. They consider its use limited for many reasons:

- Its horizontal field of view is half that of the gunner's sights (12.5° vs. 25°). It does not have the same elevation angle range as the gunner's sights. In a defilade position the vehicle may be positioned where the CVD is below the crest of the concealed location. If it does have visibility above this point, an inclined parking position may give the squad leader a view of only the sky at the CVD's maximum angle of depression, -20° . Fields of view are obstructed by the turret and launcher assembly.
- The CVD does not have a night viewing capability.
- The limited field of view makes battlefield acquisition difficult at best. Squad leaders expressed an overall difficulty in establishing

target priorities for gunners. The three power magnification was also considered a limitation in determining battle damage to targets. A 13X selection as well as 3X would be useful.

● The CVD cannot be used by most squad leaders for navigation. They stated that they were forced to do so for awhile but balked at this situation after one road march. Bruised cheekbones and poor visibility due to vibration of the CVD were the general results. Range estimation required map referencing from terrain examination. Optics did not help.

(4) Vehicle Mobility. Squad leaders responded that the ITV lacks power necessary to participate as an active element in a maneuver force. Test and threat force members recognized the ITV as adequate in it's first, fixed defensive position. Both groups recognized severe cross country mobility limitations in inclement weather exercises compared with M113A1s and M551s at OT III, Phase B. The ITV frequently had to seek alternate routes during advancing maneuvers. The squad leader must be concerned with this vehicular shortcoming when determining how to perform his mission most effectively. The vehicle, because of its weight and higher center of gravity, is simply not as maneuverable as an M113A1.

The ITV is faced with a 5MPH speed limitation when the launcher is in the erect position. This limitation, coupled with the time required to stow the launcher hinders rapid withdrawal to a secondary firing position. It also adds time to any bounding overwatch maneuver for the ITV.

(5) Navigation. The squad leader cannot safely use the CVD while travelling to aid with navigation. He is forced to use the gunner's station while travelling to follow terrain and direct his vehicle. Should contact be made, or anticipated, he must get down and let the gunner move into the turret. The squad leader is now "blind" until the vehicle stops.

A command intercommunication control box would be helpful at the gunner's station according to squad leaders and gunners. This was viewed as a necessity by cavalry squad leaders.

Navigation and command and control cannot be performed effectively from the open cargo hatch, even with a high stow mounted launcher. Observers and/or squad leaders remarked that they hit their heads whenever this was attempted.

(b) Gunner Comments.

(1) The turret. The turret is difficult to enter from the crew compartment and if stopped at points in its traverse it is not possible to exit into the crew compartment. The sight eyepiece is easily lost due to bumping and switches are subject to activation during gunner entry, or when the gunner stands on the seat. The hatch on the turret

was liked less than the M113A1 hatch. The locking latch was considered to be backwards for efficient use. The gunners were concerned about the launcher assembly's erection arms being strong enough to support the launcher in case of a total power failure. In all, reliability of the launcher was foremost on their minds.

The exposed wiring and hydraulic lines concerned them. The hydraulic lines were criticized for leakage problems. Web gear and heavy clothing gets caught on exposed wiring and lines. The hydraulic lines often become hand holds. The emergency pump (hydraulics) was almost impossible to use and at best, exhausted the users. The handle is awkward and difficult to use. Two missiles were launched while testing emergency power and both missed their targets at OT III, Phase B.

Maintenance on turret fittings was considered extremely difficult. There was very limited space to use tools (if available). Checking the hydraulic reservoir required an open hatch and the gunner often needed pliers to pull the dipstick.

A gunner's seat backrest is needed and a much better method for seat adjustment devised. The seat now often requires two men to adjust it.

The Slew Switch (Fast Slew) was mentioned by two gunners as being annoying to use. They didn't like the way it had to be depressed for use.

The turret base as well as the gunner's feet often strike the squad leader if he is at his station. Loose items on the floor get wedged under the turret. The rotating turret also catches web gear and one crew member reported having been pinned to the fire wall by a rotating turret.

An elevation angle indicator was seen as helpful to the gunner to assist in stowing the launcher. An auto-stow button was suggested to speed up stowing for travel.

The control panel received few comments in general. Green "go" lights and push-buttons instead of toggle switches were suggested. Remote adjustment controls for the night sight were judged useless.

The turret tracking controls were considered acceptable for the most part. "Deadband" was noticed but it could be compensated for by all gunners. It was remarked that constant control deflection had to be maintained on the system to keep it from "drifting and settling" slightly from a fixed point. One gunner indicated that he accidentally activated turret traverse power while climbing into the turret. Even in stow, the launcher will move. Switches are often activated accidentally.

The Missile Guidance System (MGS) is exposed at the turret base to damage from loose equipment and from crewmembers accidentally kicking it.

Electrical power to the turret and support systems was a problem noticed by gunners as well as by drivers. When the vehicle engine is off

electrical power is drained rapidly from the batteries by the turret and the radios. The ITV must be started more often than an M113A1 in order to generate electricity. Additional batteries would be useful.

(2) Gunner Sighting Systems. The daysight is seldom criticized by the test personnel, however the adjustments it requires are. "Play" has been mentioned between the sight and the Image Transfer Assembly (ITA). The continuous boresighting requirements and the collimator used to make the adjustments concern the entire crews. Collimators have had poor fits and have been difficult to use. The loader must climb onto the top deck usually to afix and adjust it. The sight cover on the launcher also causes problems. It is armor plate with no lifting handle. When closed, it is often dropped in place the last half inch altering boresight alignment retention. In all, sight adjustments are considered too sensitive.

Glare has been a problem for some gunners when they tracked into the sun. All sights suffer image degradation when used in inclement weather.

Sights were considered too exposed to hostile fire damage.

Range estimation with all sights is considered difficult even though the only concern gunners have is when the target is within maximum range.

Many gunners and squad leaders rated the night sight as the most outstanding feature of the entire system. They appreciated the need for night firing capabilities and were pleased with the sight. The current shortcoming in the sight is the ineffectiveness of the remote adjustment controls. They simply did not work during OT III. The gunners stated that the improved remote controls functioned less efficiently than the original ones. Soldiers suggested that twist/turn control would probably work better than push/pull controls. Immediate support for the night sight is an additional problem. The nitrogen bottles it uses, and the rechargeable batteries needed are expended well before their rated time. Maintenance requires specialized logistical support which the users realize is not usually available under battlefield conditions.

The Image Transfer Assembly (ITA) suffered at one point from fogging due to weather changes. It has also been susceptible to dirt collection between its upper housing and the sight system where the sight is mounted. Crewmembers noticed some vision quality loss with the ITA that does not occur with the TOW sight alone.

The optics (CVD and Sight aperture) fogged in the summer heat as a result of exposure to the body moisture of crew members. In general, optics were sensitive to moisture, dust, and mud. Sight lenses required cleaning prior to use in many of the field experiences the gunners had. Dust obscured the gunner's sight and the CVD twice during OT III, Phase B,

live fire tests. The gunner and the squad leader both need to consider terrain conditions which could hinder constant observation of the target during missile tracking.

During the tests the gunners never indicated reliance on the turret vision blocks for outside observation. The crew found the rear ramp vision block always dusty or muddy, depending on weather conditions, and of very limited use. The right rear side vision block was seldom accessible for use because of its location behind the storage point for the TOW's ground mount tripod. The driver has no field of view to his right and right rear. These various limitations to battlefield observation impact on gunner performance. The gunner could use information regarding potential targets sighted by crewmembers in the engagement process. Limitations to overall crew visibility restrict the engagement potential of the system.

(c) Driver Comments.

Drivers shared the concerns of squad leaders regarding the vehicle's lack of reliability and power. In interviews they expressed concerns with the ITV's high center of gravity, its lack of maneuverability and ability to keep pace with a mobile force. Drivers were concerned about the speed limitation they faced if they had to relocate the ITV with the launcher in the erect position. The ITV was considered top heavy even in the stowed position by more than two thirds of the drivers.

Drivers were concerned about the electrical power requirements of the overall system. One remarked that use of the infrared driving periscope was not possible when the turret was being operated. The drivers wanted the radio override switch positioned at their station so that they could respond more rapidly to march orders. The cant indicator in the driver's compartment was not difficult to use but was not considered a significant aid in positioning the vehicle in a suitable firing position. The instrument panel was considered adequate but it should be located further to the left side of the hull for easier viewing.

The space allocated to the driver in the ITV is the same as it is in the standard M113A1. Storage is a concern of drivers as is the placement of the track commander's seat which impedes entry to and egress from the driver's seat. A spring loaded track commander's seat, which stows itself when not in use would begin to solve this problem.

The driver's hatch has been criticized by all drivers. Its "pop-up" capability does not provide significant advantage over the old M113A1 driver's hatch. Wearing a combat vehicle crash helmet (CVC) causes a driver to press his head against the inside of a popped hatch to see outside to drive. This feature would be more useful if an inch or two were added to the height the hatch raises. The hatch pop up latch has caused some problems as well. The hatch, in the pop up mode has been

wn to unlatch and hit the driver during travel. The hatch pivot
nt drew several comments. Suggestions were presented ranging from
atch that pivoted over the front of the vehicle to a more frequent
e which would be stowed over the engine grill. A hatch that stows
rtically was not desired, in part because it blocks the view from
e CVD.

d. Loader/Observer Comments.

Crew members in the rear compartment have expressed concerns with
he lack of storage space for mission essential equipment and personal
gear. Some hazardous conditions result from this space problem. Loose
equipment has become wedged under the turret base. Equipment, web gear
in particular, gets tangled on exposed wiring and hydraulic lines.
Ammunition stored on top of the battery box was seen as very dangerous.

The loader's cargo hatch is extremely difficult to close and often
requires more than one crew member to complete the task. The loader's
communication connection interferes with missiles while loading is in
progress. Loaders felt the communications control box should be placed
to the right rear of the cargo hatch.

Airguard and observation from the cargo hatch is almost impossible,
even with the high stow launcher position. Observers are unable to stand
upright. Attempts to observe or navigate from the cargo hatch while
travelling have been impossible.

The seating area for the loader and observer(s) is often littered
with personal equipment and weapons not provided with permanent storage
points.

Loaders were bothered by the locking system which held missiles in
place on the launcher rails. There were failures in the mechanism which
permitted missiles to disengage from the rails and cause missfires.

The loader often hit his hand between the machinegun traverse ring,
or the machine gun stowpoint, and the discarded missile casing when
discarding to the left.

TRAINING

Training programs were monitored extensively at both the DT III and the OT III sites by ARI-Benning and Litton Mellonics researchers. The initial observations covered the following programs:

- Mechanized Infantry Gunner and Crew Training, conducted at the Yakima Firing Center by the United States Army Infantry School and including basic training in the operation and firing of both the ITV and the Ground TOW,
- Cavalry Gunner and Crew Training, conducted at the Yakima Firing Center by the United States Army Armor School and including basic training in the operation and firing of the ITV exclusively, and
- Mechanized Infantry ITV Familiarization and Tracking Training, conducted at the White Sands Missile Range by the United States Army Infantry School (in support of DT III).

a. Key Training Issues

Key training issues were identified which affected individual and crew performance during the Operational and Developmental Tests and which have importance for future operational ITV programs.

- The training programs presented at the DT III and at the OT III were adequate for the standards established by OTEA (OT III) and AMSAA (DT III). During Phase B, OT III, some timed performance tasks required repetition before all crewmen passed. This problem was probably the result of new personnel assignments, lack of timed practices, and delay-causing equipment difficulties.
- It was determined that four (4) days of training would be required to gain acceptable tracking skills and related task proficiency with the ITV. One (1) additional day would be required for crew performance testing and qualification firing. Three (3) days of tactical training to gain operational experience is recommended to accompany basic ITV training. A need for remedial TOW training may lengthen some programs. Much of the additional training, however, could be conducted at assigned unit levels.
- OT III training data show no evidence of negative transfer from ground mounted TOW tracking to ITV tracking. Superior scores (M70) of infantry gunners can in part be attributed to selection; but also in part to apparent skill transfer between systems. A majority of the gunners (all crew men with tracking experience) in training on both systems indicated that they would have no trouble going back and forth between tracking with the ground TOW and the ITV.

- A large decrement in ITV tracking scores (see Table 8) compared to the small drop in TOW scores (see Table 8) after a several week layoff indicates that long term retention for ITV tracking skills is poorer. This may, in part, be attributed to the greater complexity of the ITV system (e.g., its rate tracking mode compared to position tracking of the TOW) or perhaps to the generally lesser familiarity with the ITV system for most test participants.

- ITV tracking training with both the M70 jeep mounted target board (used by Infantry) and the ETS used by (Cavalry) in Phase B, OT III, resulted in comparable performance effectiveness of both groups against Manned Evasive Target Tanks (METTs). Test subjects thought both target systems provided different and useful kinds of tracking practice.

- Training at both test sites was frequently interrupted because of equipment breakdowns during Phase A and at OT III, Phase B. This impacted on schedules and numbers of crew members per ITV. At OT III, Phase B, in January 1978, this effect was felt during refresher training. Crew response to questionnaires indicated a need for better scheduling and increased numbers of ITVs for training. The platoon leaders and their troops were critical of the training schedule. Long hours were planned with no consideration given to maintenance or road travel times to and from training areas. This had an impact on morale.

b. Quality of Instruction

Both the Cavalry and the Infantry OT III Post-Training Questionnaire results showed that crew members considered the overall quality of instruction to be very good. They categorized the written material, the instructors, and the program organization as being good to very good. Fourteen of the 24 crew members felt the training program should have been longer. Nine of 12 infantry squad leaders and gunners indicated a need for more ITV tracking practice. More TOW practice was felt to be necessary as well. Most subject areas were considered easy to learn with night tracking and Target Engagement Techniques considered more difficult.

Interviews after questionnaire completion revealed that most test personnel did not arrive at the OT III knowing enough about the nature and parameters of their participation. The extensive interview results summarized in Appendix D, the Litton Mellonics Training Report, generally confirm the questionnaire responses. The Cavalry felt that some parts of the program were a bit too short. They felt generally that the ITV was not suitable in its current configuration for the basic Cavalry combat missions. One entire crew (5) at OT III, Phase B, was new to the ITV.

General comments, both written and verbally provided during interviews, included the following recommendations:

- There should be one ITV available for every crew during training.

. Maintenance problems with the ITVs disrupted scheduled training consistently.

. More tracking practice against tanks evasive targets is needed to gain and maintain proficiency with the ITV systems.

At OT III, Phase B, mechanical problems which interrupted training added to scheduling problems. There was not enough consideration given to new personnel training requirements. As a refresher, the programs for Cavalry and Infantry were considered sufficient. New crew members, however, commented that they frequently missed important points in the instruction because of its pace. This shortcoming is more condemning of test planning than of instructors tasked with the training. Ample time was available ($3\frac{1}{2}$ months) to anticipate major personnel changes and to request training program revisions for Phase B.

c. Gunner Qualifications

Median gunner qualification scores, recorded using the M70 and jeep mounted target board are difficult to compare directly from one program to another. So many variations existed in training and tasks that only general conclusions can be supported. The same problems exist when a comparison of missile live fire records is made with M70 scored gunner qualifications. Equivalent conditions for enough firings did not exist to make significant comments related to training.

The best evaluation of the qualifications of crewmen with sufficiently similar training and experience to answer key training issues comes from data collected at OT III. Six infantry gunners and squad leaders provide a longitudinal data base upon which can be made some general inferences regarding tracking skill across time. These six men participated in the tracking exercises of OT III, Phase A, had no tracking practice for almost three and a half months (while ITV repairs and modifications occurred), and then returned for all Phase B tracking activities. ITV M70 tracking score loss was evident upon return for Phase B. Much of this presumably was skill loss, but some may have been due to differences in test circumstances. A jeep carried the M70 target on smooth asphalt in Phase A tracking but an M113A1 target carrier driven on the road shoulder was used for the test at the beginning of Phase B.

Phase B, post-training ITV scores (see Table 8) indicate that the refresher training and tracking practice brought the gunners up to established record standards. They appear to have retained their skill as indicated by the Post Test scores.

d. Program Changes

Task A (5 mr), the slowest tracking task, produced the lowest mean scores during each qualification. This, according to gunner comments is the most difficult tracking task. More emphasis in training programs should be placed on task A. This recommendation relates to the ground mounted TOW as well (see Table 8).

e. Evasive Target Simulator (ETS)

The ETS received minimum use at the DT III and OT III sites during early training. It was used as the exclusive training device during OT III, Phase B, by the Cavalry for ITV tracking practice. The Infantry conducted ground TOW tracking training during this phase with it as well. The post-training ITV and TOW qualification was conducted using the jeep mounted M70 target source, which the Infantry ITV gunners trained with. The Cavalry scored comparably (see Table 9) with the Infantry, having practiced with the ETS only.

The ETS has a tremendous potential for unit training and its development is strongly endorsed by ARI. It allows the unit commander freedom to provide feedback in training in confined areas without the need for external resources. Ranges and target vehicles are not required. The DT III and OT III showed that the ETS is capable of reliability exceeding the jeep mounted target source. Test subjects indicated an advantage in training programs combining the use of both target sources. Further details about the ETS are contained in a memo supporting it's continued development and use (see Appendix C) and in the Litton report on training (see appendix D).

Table 8

^{*}Infantry OT III, Phase A and Phase B ITV Qualification Scores

Test	Phase A			Phase B								
				Pre-Training			Post Training			Post Test		
	**			A	B	C	A	B	C	A	B	C
ITV Mean Scores	640	824	702	382	518	451	725	864	809	663	809	737
TOW Mean Scores	644	853	729	620	823	805	741	902	788	706	872	801

*N = 6

**A, B and C are tracking tasks using different target movement speeds.

Table 9

Cavalry and Infantry Post Training ITV Qualification Scores (M70)

		Tracking Tasks		
		A	B	C
Cavalry *	(N = 10) \bar{x}	623	815	761
Infantry #	(N = 12) \bar{x}	714	863	783

* 50% New Personnel

33% New Personnel

The training portion of this research effort was carried out by Litton-Mellonics. Findings in the above section were drawn largely from their report which is an excellent source of additional training information (Evaluation of Training for the Improved TOW Vehicle (ITV) Operational and Developmental Tests III (OT/DT III) by Dr. W. Middleton. A copy of his report is included in our paper as appendix D. Dr. Middleton's data and assistance have also played a part in other portions of the ARI paper - particularly in the recommendations section which follows.

RECOMMENDATIONS

The soldier users who spent several months testing the ITV made many general and specific recommendations for improvements and for correction of defects in the ITV. Most of these are covered in detail in the body of this report and are only summarized below.

THE VEHICLE IN GENERAL

a. Reliability/Ruggedness

The concept of the ITV was viewed as good but soldiers felt the vehicle was not ready to be tested during OT/DT III. The bottom line to most recommendations was - make the ITV rugged and reliable.

b. Keep Up and Go Where Other Vehicles Can Go

The added weight and change in center of gravity degraded the ITV vehicle compared with the standard M113A1. Those who had heard of the product improved M113 program felt it should be implemented as rapidly as possible and used as the ITV carrier.

c. Speed Into and Out of Action

The inability to move the vehicle rapidly with the launcher erect, the frequent required boresighting, and the delays getting ready to fire or depart after firing were all seen as needing major improvements.

d. Less Frequent Boresighting

Improvements in the mounting of sights and in stabilizing adjustments were viewed as critical. One need is to make certain what boresighting really is required. At a minimum the ITV must be able to move, fire and hit without frequent boresighting.

e. Night Sight Controls

All sight control functions should be remoted (including on/off and focus), the full extent of function adjustment should be remotely available, and the adjustments must remain stable.

f. Command and Control - CVD

The squad leader must be in a position to control his vehicle and his crew and to interact with other vehicles or external persons. The data from the soldiers make clear the need to improve visual capability (CVD)

from the squad leaders station. Having excellent visual capability at both that station and in the turret at times will be critical for command and control. Such improvements as have been recommended for the CVD throughout this paper are important for mechanized infantry use, but could greatly aid in cavalry missions as well.

g. Visibility for Scouts

The use of the cargo hatch for observation is problematic. Everything possible should be done to eliminate hazards and visual obstructions.

h. Backup Power

There needs to be a backup system that makes it possible to fire missiles when electrical or hydraulic failure occurs. The system in use at DT/OT III had no such capability.

The above eight areas represent the basic things the ITV users revealed time and again in their data - improvements needed to allow the ITV to function more effectively in the tactical environment. Soldiers had many additional recommendations that related to specific crew stations. These are summarized below.

SQUAD LEADER'S STATION

- The squad leader's seat definitely must be improved. It is probably in the wrong location. It should spring out of the way when not in use.
- The Commander's viewing device (CVD) is too limited in field of view and occluded by too many things on top of the vehicle. It is also too limited in height. The squad leader will not be able to see the battlefield from defilade,
- The squad leader's personal weapon must be stored where he can easily reach it.

GUNNER'S STATION

- There has to be a better way of installing the day and night sights. The night sight is particularly hard to install at night. Not only is the operation time consuming, but also the interface hardware gets damaged, thus, compounding the problem.
- The nightsight batteries and nitrogen bottles are expended too fast. This will be a real logistics problem in combat.

- There should be an on-off switch and remote focus for the night sight in the turret.
 - The gunner's eyepiece shield is not well designed. It sticks out too far, gets in the way, and may get torn off when the gunner stands in his hatch.
 - A cover is needed for the daysight.
 - Recommended procedures and equipment should be available for cleaning the lenses of the day and night sights.
 - Several squad leaders and gunners have commented that they would like a wider field of view with the low magnification sight.
 - Stadia lines are needed in the daysight to show range for maximum engagement.
 - A wider area of the azimuth ring should be illuminated during night operations.
 - The collimator is very difficult to install. This is also much harder to do at night, and the nightsight lens is quite vulnerable in the process.
 - There should be remote gauges near the day and night sights so the driver can boresight without the need to interact with the gunner. Communication between the driver and gunner is difficult with all the noises that are going on, and it would be even more difficult in combat.
 - The boresight adjustment controls are too sensitive. The process is too time consuming when boresight is too far out of adjustment to begin with.
 - Boresighting appears to be very sensitive and easily affected by movement of the turret or vehicle.
 - Latches which hold the gunner's hatch cover and the driver's hatch cover open need a better lock so the hatches will not fall during moving operations.
-
- The gunner's seat is hard to get in and out of, and it is in the way when the gunner stands in the hatch.
 - A back support is needed for the gunner's seat.
 - When the gunner's seat is all the way down it is hard to remove the MGS, and it is hard to adjust the seat from off to the side.

- The MGS is vulnerable to damage from the gunner's feet, and the MGS plug hits the squad leader when seated in the Commander's seat.
- The MGS is difficult to install because the handles are in the wrong position.
- The M60 is in the way. The squad leader may use it as a missile guide during reload. It has been hit while throwing the expended missiles out during reload. It is also very limited in field of action, difficult to traverse on the ring and the gunner is vulnerable when using it. If the gunner stands on the seat, he is too high; if he stands on the deck, he is probably too low and the gunner's seat is in the way.
- The intercom box for the gunner should be rewired so that he can talk on either the intercom or the radio.
- The activator switches in some of the tracking control handles are difficult to hold in.
- Lack of response near the neutral position of the turret controller (deadband) has bothered some of the crewmen.
- The use of a joy stick type of tracking control should be seriously considered to improve initial skill and reduce performance loss between practice sessions. A small joy stick pointed forward and slightly upward would be easy to use and to teach. The new gunner would only need to be told: stick up - missile up, down for down, left for left and right for right.

DRIVER'S STATION

- The driver's swivel hatch can swivel and hit the driver if it is not properly secured. At least 3 drivers have been hit by it when they thought they had the swivel latched in place.
- The driver's pop- hatch mode probably should be raised higher to permit easier viewing particularly with night vision goggles.
- It is difficult to close the driver's hatch from the outside.
- Driver's frequently suggest moving the control panel more to their left.

LOADER'S AND OBSERVER'S AREA

- During loading, the final placement of the missile all the way into the launch tube is difficult. This may be due to the fact that some missiles have become damaged during practice.

- Some loaders have trouble getting the missile on the launcher guide rails during loading at night. (redesign of the guide rails and luminescent paint was suggested).
- The loader will have to wear gloves for reload because the missiles will be hot. They should practice with gloves on.
- The vertical steel plates on the top deck are in the way when throwing expended missiles out. If one of the plates is not dropped prior to manual erection injury to a hand will occur while cranking.
- The latch holding the cargo hatch door completely open does not release easily. It is also difficult to get hold of the latch handle.
- The intercom box for the loader should be moved to the right (missile) side of the vehicle. In its present location, the loader's CVC cord gets in the way of the squad leader during Reload. Also, the loader's CVC cord is apparently too short to allow the loader to boresight.
- A light is needed over the missile storage rack.

MISCELLANEOUS

- It is very hard for the gunner to remove the dip stick to check the hydraulic fluid level.
- The crewmen should have more tools and authorization for maintenance in the field. Organizational maintenance should also have more authorization for field maintenance. They are very limited in what they can do now.
- The Pre-Ops take too long. More efficient procedures should be developed.
- It is necessary to run the engine frequently to charge the battery for tracking. This would not be satisfactory in combat because it could give away the ITV's position.
- There is a need for better stowage(e.g., system of straps, stow more things outside, possibly putting duffel bags outside in metal containers for protection).
- Each man should have his own duffel bag. It is too difficult for two men to share a bag under combat conditions.
- There is a major need to remove every possible protruding knob, box, etc., to minimize hazards and snags to clothing and web gear.

APPENDIX A - 1

NAME _____ DATE _____

ITV HUMAN FACTORS QUESTIONNAIRE

One important part of this operational test is to ask each of you who has been working with the ITV these past several weeks to give feedback about your experiences. We need to be sure the equipment is safe and usable before purchase decisions are made. Therefore, we are going to ask you many questions about: conditions in the vehicle, possible safety hazards, difficulty using the equipment, problems doing your assigned job, difficulty with communication and command and control, and the like. In answering this questionnaire please give information only about your own personal experiences with the ITV.

For each statement in the questionnaire please select one of the four answers listed below. Your answers will tell us how much of a problem each questionnaire item has been for you throughout the test while you were operating the ITV and its various pieces of equipment. The answer choices are:

- 0 no problem
- 1 a minor problem
- 2 a moderate problem
- 3 a serious problem

In deciding your answer, please consider both how often and how much the item has been a problem for you.

- _____ (1) Objects sticking out in the vehicle that were safety hazards.
- _____ (2) Amount of padding on periscopes.
- _____ (3) Unsafe storage of any weapons.
- _____ (4) Unsafe conditions while any weapons were being fired.

- _____
(5) Controls in the vehicle that could be activated accidentally and result in a safety hazard.
- _____
(6) The amount of safety crash padding in the vehicle.
- _____
(7) Not enough air when the vehicle was buttoned up.
- _____
(8) Noise that caused you to have trouble hearing communications.
- _____
(9) Noise that was annoying to you.
- _____
(10) Noise that caused hearing problems lasting after the noise stopped.
- _____
(11) Amount of lighting inside the vehicle.
- _____
(12) The placement of lights inside the vehicle.
- _____
(13) Adequacy of the lighting at my duty position.
- _____
(14) Something about the vehicle that made riding or being in it very fatiguing.
- _____
(15) General discomfort while in the vehicle for only short time periods.
- _____
(16) General discomfort while in the vehicle for long time periods.
- _____
(17) Discomfort while riding at slow speeds.
- _____
(18) Discomfort while riding at high speeds.
- _____
(19) Crowding or cramped space while in the vehicle.
- _____
(20) High temperature inside the vehicle.

- (21) Low temperature inside the vehicle.
- (22) Any conditions that made you feel motion sick.
- (23) Vibration in the vehicle.
- (24) Fumes from the vehicle.
- (25) Fumes from missiles during live fire.
- (26) The amount of ventilation in the vehicle.
- (27) Being bounced around while the vehicle was under way.
- (28) Outside lights on the vehicle that caused glare.
- (29) Getting cramped so that it was hard to dismount or do your job after dismounting.
- (30) Too little leg room.
- (31) Too little head room.
- (32) Too little hip or shoulder room.
- (33) Loading plan of the vehicle.
- (34) Ability to get your individual weapon when required.
- (35) Adequacy and accessibility of safety/emergency equipment.
- (36) Ability to care for injured persons in the vehicle.

- ____ Headset/helmet design for comfort.
(37)
- ____ Headset/helmet difficulties during dismount.
(38)
- ____ Headset cord getting in the way while doing my job (Yours or other crew members).
(39)
- ____ Malfunctions of the radio/intercom system.
(40)
- ____ Broken headsets or spaghetti cords.
(41)
- ____ Ramp operation or obstructions.
(42)
- ____ Difficulties adjusting your seat.
(43)
- ____ Power in the engine of the vehicle.
(44)
- ____ Feeling motion sick when buttoned up.
(45)
- ____ Feeling motion sick when riding for long periods at high speeds.
(46)
- ____ Difficulty entering the vehicle to get to your seat or riding position.
(47)
- ____ Difficulty getting out of the vehicle from your seat.
(48)
- ____ Clothing and web gear snagging when entering or leaving vehicle.
(49)
- ____ Not enough room to put my feet while sitting on my seat.
(50)
- ____ Difficulty getting over or by other squad members' seats.
(51)
- ____ Difficulty seeing through periscopes because of mud, etc., covering them.
(52)

- _____
(53) Difficulty seeing because periscopes were fogged.
- _____
(54) Difficulty seeing through periscopes because they vibrated.
- _____
(55) Difficulty seeing through periscopes because of glare.
- _____
(56) Difficulty with loose items (e.g., expended cartridges) on the floor.
- _____
(57) Speed of the vehicle.
- _____
(58) Maneuverability of the vehicle.
- _____
(59) Ability of the vehicle to climb hills.
- _____
(60) Ability of the vehicle to go into and get out of steep defilade positions.
- _____
(61) Danger to the squad during rotation of the turret.
- _____
(62) Ability to operate the ITV while wearing CBR gear.
- _____
(63) Ability to operate the ITV while wearing cold weather gear.
- _____
(64) Danger due to the placement of the smoke grenade launchers.
- _____
(65) Danger due to the closeness of the Squad Leader's position (in the modified vehicles) to the turret.
- _____
(66) Possibility of getting a foot caught while the turret is rotating.
- _____
(67) Things getting underneath the turret on the floor of the vehicle.
- _____
(68) Overpressure during missile firing.
- _____
(69) Sufficient numbers and locations of handholds (straps, handles, etc).

- (70) Adequacy of working space at my duty station.
- (71) M16A1 rifle damage due to inadequate storage racks.
- (72) Damage to other equipment due to inadequate storage.
- (73) Difficulty keeping oriented while inside the vehicle.
- (74) Damage to personal gear because of where personal gear had to be stored.
- (75) Sharp points on the cam rail around the gunners cupula.
- 1
(76) Questionnaire Number
- 1
(77) Card Number
- (78) ID Number
- (79)
- (80)

ITV Human Factors Questionnaire (continued)

SQUAD LEADER'S QUESTIONS

- (1) Ability to see at night from the Squad Leader's (SL's) seat.
- (2) Ability to see in daylight from the SL's seat.
- (3) Ability to see in bad weather from the SL's seat.
- (4) Difficulty seeing through the commander's viewing device (CVD) because of the sun's glare.
- (5) Difficulty seeing through the CVD because of heatwaves.
- (6) Difficulty seeing through the CVD because of dust, smoke or haze.
- (7) Difficulty seeing through the CVD because of vibration.
- (8) Difficulty seeing through the CVD because of background clutter.
- (9) Difficulty seeing through the CVD because of glare.
- (10) Difficulty seeing through the CVD because of dirt, mud, or debris on the lenses.
- (11) Difficulty seeing through the CVD because of rain, snow or fog on the lenses.
- (12) Difficulty seeing through the CVD because of unclear optics.
- (13) Difficulty seeing through the CVD because of too little magnification.
- (14) Difficulty seeing through the CVD because the field of view was too small.
- (15) Ability to detect targets with the CVD.
- (16) Ability to identify targets with the CVD.
- (17) Ability to prioritize targets using the CVD.
- (18) Ability to keep track of your full area of battlefield responsibility using the CVD.
- (19) Difficulty seeing through the CVD while the vehicle is moving.
- (20) Difficulty seeing through the CVD at night.
- (21) Ability to estimate range to a target using the CVD.
- (22) Obstructions blocking your view when you are trying to see using The CVD.

- (23) SL's seat too close to the driver's seat.
- (24) SL's seat too close to the turret.
- (25) Danger to the SL when the turret is moving.
- (26) Comfort while sitting on the SL's seat.
- (27) Ability to stay on the SL's seat.
- (28) Lack of back support for the SL's seat.
- (29) Seat height.
- (30) Any difficulties with your seat during mounting or dismounting.
- (31) Adequacy of the radio equipment.
- (32) Adequacy of the intercom equipment.
- (33) Ability to control the activities of the driver while you were in the vehicle.
- (34) Ability to control the activities of the driver while you were dismounted.
- (35) Communication with other vehicles to coordinate targets, etc., while you were in the vehicle.
- (36) Communication with other vehicles to coordinate targets, etc., while you were dismounted.
- (37) Difficulty knowing where the turret was pointed.
- (38) Ability to guide the gunner to a target you had located.
- (39) Ability to control other actions of the gunner while you were inside the vehicle.
- (40) Ability to control actions of the gunner while you were dismounted.
- (41) Difficulty with command of your squad because of delays in your ability to dismount the vehicle.
- (42) Difficulty with communication during mount or dismount of the vehicle.

- (43) Difficulty doing your job while on the move in the vehicle.
- (44) Difficulty getting set up rapidly to engage a target.
- (45) Difficulty getting set to move away from the firing area after missile impact.
- (46) Too little space in the Squad Leader's station.
- (47) Difficulty operating the radio from the SL's seat.
- (48) Difficulty reaching needed stored items.
- (49) Difficulty reaching your personal weapon in its stored position.
- (50) Difficulty controlling the actions of the loader from the SL's position.
- (51) Sharp edges or other hazards at the station (other than the turret).
- (52) Ability to navigate while in SL's seat.
- (53) Ability to move from SL's station to turret during travel.
- (54) Ability to determine azimuth to target at night.
- (55) Ability to navigate and control from loader's hatch while traveling.
- (56) Difficulty getting comfortable while using the CVD.
- (57) CVD too short to be able to see while in full defilade.
- (58) Ability to see with the CVD when driver's hatch is open.
- (59) Missile Guidance set plug hitting person sitting on the SL's seat.
- (60) Difficulty communicating with the other vehicle in the section.
- (61) Overall difficulty being able to see well enough to do my job in the ITV.

1 (76) Questionnaire Number

2 (77) Card Number

 (78) ID Number

 (79)

 (80)

ITV Human Factors Questionnaire (continued)

GUNNER'S STATION QUESTIONS

- _____(1) Getting into turret.
- _____(2) Getting out of turret.
- _____(3) Danger because track commander's seat is close to turret.
- _____(4) Uncovered wires.
- _____(5) Uncovered hydraulic tubes.
- _____(6) Heat from hydraulic accumulator and tubes.
- _____(7) The slew switch on the turret control handles.
- _____(8) Operating the hand control to track with the ITV in azimuth (left and right).
- _____(9) Operating the hand control to track with the ITV in elevation (up and down).
- _____(10) The amount of "deadband" in the hand control (around the center where moving the control doesn't seem to move the turret).
- _____(11) Ability to track when the vehicle is not level.
- _____(12) Confusion due to which way I had to move the ITV hand control to make the turret go left and right.
- _____(13) Confusion due to which way I had to move the ITV hand control to change the TOW tube elevation.
- _____(14) Slow speed tracking.
- _____(15) Medium speed tracking.
- _____(16) High speed tracking.

- (17) The use of the slew switch.
- (18) Operating control panel switches while tracking.
- (19) Confusion with lights on the control panel.
- (20) Confusion because red lights indicate "warnings" as well as "go" conditions.
- (21) Difficulty tracking because of heatwaves.
- (22) Difficulty tracking because of dust, smoke or haze.
- (23) Difficulty tracking because of vibration.
- (24) Difficulty tracking because of missile flare.
- (25) Difficulty tracking because of background clutter.
- (26) Difficulty tracking because of glare.
- (27) Difficulty tracking because of dust, mud, or debris on lenses.
- (28) Difficulty tracking because of rain, fog or snow on lenses.
- (29) Difficulty tracking because of unclear optics.
- (30) Difficulty making adjustments in brightness, contrast or field of view on the night sight.
- (31) Difficulty setting or changing night sight focus for distance.
- (32) Difficulty turning the night sight on and off.

- (33) Turning the day sight/tracker on and off.
- (34) Using the boresight collimator.
- (35) Adjusting cross-hair focus.
- (36) Switching from one sight or power to another.
- (37) Ability of all sight pictures to remain boresighted with one another.
- (38) Timing of the select and arm switch closings.
- (39) The gunners hatch.
- (40) Ability to adjust the gunner's seat.
- (41) Sliding off the gunner's seat.
- (42) Riding backward in the modified seat.
- (43) Lack of back support on the seat.
- (44) Place for gunner's feet when seated in the turret.
- (45) Location and accessibility of the missile guidance set.
- (46) Estimating range with the hatch open.
- (47) Estimating range through the viewing blocks (when launcher is stowed).
- (48) Estimating range through the ITV sights.

- _____
(49) Keeping track of the "battlefield" situation through the ITV sights (launcher erect).
- _____
(50) Locating targets through the ITV sights (launcher erect).
- _____
(51) Identifying targets through the ITV sights (launcher erect).
- _____
(52) Keeping track of where the launcher is aimed relative to the front of the vehicle.
- _____
(53) Knowing where to move the turret when someone else gives you a target vehicle.
- _____
(54) Difficulties getting fire control information from the track commander or others.
- _____
(55) Confusion because of having to do several things at once.
- _____
(56) Difficulty operating the backup hydraulic pump.
- _____
(57) Not being able to see who or what is on top of the vehicle.
- _____
(58) Difficulty moving quickly to 180° in azimuth to stow the launcher.
- _____
(59) Difficulty in quickly getting to the proper elevation to stow the launcher.
- _____
(60) Difficulty getting the launcher in position to be ready to move it to reload.
- _____
(61) Blind spots when the launcher is stowed.
- _____
(62) Things that could jam the turret on the outside of the vehicle.
- _____
(63) Adequacy of space in the turret (head room, leg room, shoulder room, etc.).
- _____
(64) Sharp edges or knobs in the turret.

- (65) Hazards you bumped into when entering or leaving the turret.
- (66) Height and location of the ITV control panel.
- (67) Lack of an elevation indicator.
- (68) Difficulty operating the turret in the dark.
- (69) Difficulty finding things in the dark.
- (70) Mud being thrown on you, the sights or the weapons when the vehicle is on the move.
- (71) Operation of the machine gun.
- (72) Things in the way of operating the machine gun.
- (73) Inability to cover the necessary area with the machine gun.
- (74) Brass from the machine gun getting in the way (for example, under foot).
- 1 Questionnaire Number
(76)
- 3 Card Number
(77)
- ID Number
(78)
- (79)
- (80)

ITV Human Factors Questionnaire (continued)

GUNNER'S STATION QUESTIONS (continued)

- _____ (1) Difficulty hearing/communicating with the track commander or others.
- _____ (2) Standing on the gunner's seat during travel.
- _____ (3) Being too high in the hatch while standing on the gunner's seat.
- _____ (4) Being thrown around and hitting things (e.g., hatch cover, eyepiece) while standing on the gunner's seat during travel.
- _____ (5) Exposure while firing the machine gun.
- _____ (6) Difficulty loading and reloading the machine gun (e.g., using 100 and 200 round boxes).
- _____ (7) Putting the machine gun into operation or stowing it.
- _____ (8) Ammunition box getting in the way.
- _____ (9) Difficulty determining vehicle angle to avoid getting a fire interrupt.
- _____ (10) Lack of a handle on the night sight cover.
- _____ (11) Activator switches on the tracking hand controller difficult to hold in.
- _____ (12) Difficulty checking the hydraulic level.
- _____ (13) Difficulty with fogging in the image transfer assembly.
- _____ (14) Gunner check lists too long and too slow a process.
- _____ (15) Difficulty with the latch on the gunner's hatch.
- _____ (16) Difficulty tracking evasive targets that suddenly changed direction.
- _____ (17) Difficulty staying on target when the accumulator pressure motor turned on.
- _____ (18) Difficulty seeing when the launcher is stowed and the vehicle is buttoned up.

ITV Human Factors Questionnaire (continued)

GUNNER'S STATION QUESTIONS (continued)

- (19) Difficulty seeing the azimuth ring at night.
- (20) Difficulty reading the azimuth ring because the pointer is off on the right side.
- (21) Difficulty installing or removing sights.
- (22) Difficulty installing or removing collimator.
- (23) Lack of covers for all sights.
- (24) Difficulty keeping lenses clean.
- (25) Lack of stadia lines in the day sight/tracker to help estimate range.
- (26) The field of view in the low power sight not being wide enough.
- (27) Boresight adjustments too sensitive and hard to set.

- 1 (76) Questionnaire Number
- 4 (77) Card Number
- (78) ID Number
- (79)
- (80)

ITV Human Factors Questionnaire (continued)

DRIVER'S QUESTIONS

- _____ (1) Difficulty steering the vehicle.
- _____ (2) Difficulty with the operation of the accelerator.
- _____ (3) Transmission shifting too slowly.
- _____ (4) Any other difficulty with operation of the transmission.
- _____ (5) Difficulty with the operation of the brakes.
- _____ (6) Difficulty with track replacement.
- _____ (7) Difficulty reading any visual display.
- _____ (8) Difficulty operating any other controls.
- _____ (9) Adequacy of storage in the driving compartment.
- _____ (10) Vision in daylight when the hatch was open.
- _____ (11) Vision at night when the hatch was open.
- _____ (12) Vision through the periscopes in daylight when "buttoned up".
- _____ (13) Difficulty seeing through the periscopes because of the sun's glare.
- _____ (14) Vision through the periscopes at night when "buttoned up".
- _____ (15) Vision during bad weather when the hatch was open.
- _____ (16) Vision during bad weather when "buttoned up".
- _____ (17) Difficulty seeing with the blackout lights.
- _____ (18) Difficulty seeing with the headlights.
- _____ (19) Any other obstructions to vision.
- _____ (20) Adequacy of mud flaps.
- _____ (21) The lack of a windshield.
- _____ (22) Getting gas in the "bilge" during refueling.

- (23) Weapon(s) being fired near your hatch.
- (24) Difficulty knowing where the main gunner's weapon(s) were pointed relative to the front of the vehicle.
- (25) Difficulty coordinating with the gunner when the track commander was dismounted.
- (26) Difficulty coordinating with the track commander.
- (27) Adequacy of the night vision equipment.
- (28) Difficulties with the driver's hatch.
- (29) Too little space in the driver's compartment.
- (30) Difficulty reaching tools, grease gun, or personal items.
- (31) Difficulty reaching intercom controls.
- (32) Difficulty seeing all instruments in some driving positions.
- (33) Difficulty reaching things while working in the engine compartment.
- (34) Not enough power to climb hills fast.
- (35) Not enough power for use in mud.
- (36) Difficulty because of the higher center of gravity of the ITV compared with the M113A1.
- (37) Difficulty because of a loss in mobility of the ITV compared with the M113A1.
- (38) Difficulty because of a loss in power of the ITV compared with the M113A1.
- (39) Difficulty because of a loss in acceleration of the ITV compared with the M113A1.
- (40) Difficulty moving the ITV with the launcher erect.
- (41) Difficulty driving the ITV with the launcher in high stow.
- (42) Difficulty getting the vehicle level enough for use of the ITV launcher.

- (43) Adequacy of the pitch and cant indications in the driver's compartment.
- (44) Difficulty using the night vision goggles when in the "pop-hatch" mode.
- (45) Loss of traction on hills.
- (46) Problems climbing hills at an angle because of concern about the ITV having a higher center of gravity.
- (47) Difficulty hearing or understanding instructions from the TC.
- (48) Difficulties with the intercom system.

- 1 (76) Questionnaire Number
- 5 (77) Card Number
- (78) ID Number
- (79)
- (80)

ITV Human Factors Questionnaire (continued)

LOADER'S QUESTIONS

- _____ (1) Adequacy of my seat.
- _____ (2) Not knowing where you are because of inability to see out of the vehicle enough..
- _____ (3) Sharp edges in the area where you have to operate.
- _____ (4) Difficulty coordinating with the track commander.
- _____ (5) Difficulty coordinating with the gunner.
- _____ (6) Ability to hear commands.
- _____ (7) Ability to see squad leader signals from your seat in the vehicle.
- _____ (8) Noise in the vehicle during live firing.
- _____ (9) Cargo hatch not latching high enough so that I can load missiles easily.
- _____ (10) Difficulty with the missile latch system so I can't be sure the missile is loaded properly.
- _____ (11) Awkwardness of loading the ITV from inside the vehicle.
- _____ (12) Difficulty holding the weight of missiles at the angle required for loading.
- _____ (13) Difficulty loading missiles when the ITV isn't level.
- _____ (14) Headset cords in the way while loading missiles.
- _____ (15) Headset cords in the way doing other jobs.
- _____ (16) Difficulty throwing missile casings out the right side of the ITV.

- (17) Difficulty throwing missile casings out the left side of the ITV.
- (18) Difficulty using the intercom box in it's present location.
- (19) The headset cord not being long enough to reach where I had to go.
- (20) Difficulty with the missile load rails.
- (21) Damage to things while throwing missile casings away.
- (22) Machine gun butt clamp getting in the way or getting damaged by cargo hatch.

- 1 (76) Questionnaire Number
- 6 (77) Card Number
- (78) ID Number
- (79)
- (80)

ITV Human Factors Questionnaire (continued)

OBSERVER'S QUESTIONS

- _____ (1) Adequacy of my seat.
- _____ (2) Not knowing where you are because of inability to see out of the vehicle enough.
- _____ (3) Sharp edges in the area where you have to operate.
- _____ (4) Difficulty coordinating with the track commander.
- _____ (5) Difficulty coordinating with the gunner.
- _____ (6) Ability to hear commands.
- _____ (7) Ability to see squad leader signals from your seat in the vehicle.
- _____ (8) Noise in the vehicle during live firing.
- _____ (9) Headset cords in the way while doing your job.
- _____ (10) Lack of headroom while observing.
- _____ (11) Obstructions to vision while observing.
- _____ (12) Fatigue in legs while observing.
- _____ (13) Sharp edges where you have to stand to obserye.
- _____ (14) Difficulty communicating while observing outside the vehicle.
- _____ (15) Headset cord not long enough to reach where I needed to go.
- _____ (16) Difficulty hearing instructions given by the TC and others.

- ____ 1 (76) Questionnaire Number
- ____ 7 (77) Card Number
- ____ (78) ID Number
- ____ (79)
- ____ (80)

APPENDIX A - 2

NAME _____ DATE _____

ITV JOB _____

ITV RATINGS

Please rate how good you feel that the XM901 - ITV is on the following several things. In deciding your ratings please consider how well you think the ITV would perform in combat, based upon your experiences in this test program.

For each statement below please select one of the following five answers.

1 = Excellent

2 = Good

3 = Fair

4 = Poor

5 = Very Poor

Please mark your answer choice (1, 2, 3, 4, or 5) on the line in front of each statement below.

1. _____ Safety of the weapons.
2. _____ Safety of turret operations.
3. _____ Ability to detect targets.
4. _____ Ability to identify targets.
5. _____ Ability to track targets.
6. _____ Ability to hit targets.
7. _____ Ability to keep the system boresighted.
8. _____ Ability to move to a new position and fire without need for new boresighting.
9. _____ Ability to keep the optics clean enough to detect targets and fire missiles.

10. _____ Vulnerability of the ITV.
11. _____ Protection for the Gunner.
12. _____ Ruggedness of the ITV.
13. _____ Reliability of the ITV.
14. _____ Ability to set up quickly to fire.
15. _____ Ability to stow launcher and depart firing area quickly.
16. _____ Ability to reload quickly.
17. _____ Overall design for crew member ease of use of the ITV.
18. _____ Ability to operate in snow and ice.
19. _____ Ability to operate in rain and mud.
20. _____ Ability to keep the ITV operational.
21. _____ Ability to avoid detection.
22. _____ Ability to see well in daytime.
23. _____ Ability to see well at night.
24. _____ Ability to keep up with other vehicles.
25. _____ Ability to go where other vehicles can go.
26. _____ Ability to get in and out of defilade.
27. _____ Ability to observe while moving.
28. _____ Ability to operate the vehicle and missile system in rugged and sloping areas.
29. _____ Taking all of the above points into account (plus any other features you feel are important) please give an overall rating of the ITV as a missile launching vehicle for combat use.

30. What are the best things about the ITV?

31. What are the worst things about the ITV?

4
(76) Questionnaire Number

1
(77) Card Number

(78) ID Number

(79)

(80)

APPENDIX A -3

NAME _____ DATE _____
ITV JOB _____

QUALITY OF DESIGN/REDESIGN REQUIREMENTS QUESTIONNAIRE

Some of the following parts or features of the ITV might be improved by additional redesign efforts before the vehicle goes into production. We need your help in finding out what the need may be. Please rate each item listed below considering your experiences during training, field exercises and live fire. Use the following scores to show your ratings:

- 1 = Excellent as is - I like it.
- 2 = Acceptable as is - I would use it as is.
- 3 = Moderate problem - Change would be helpful, but not required.
- 4 = Serious problem - Item should be changed/improved before production.
- 5 = Very serious problem - Item must be changed/improved before production.

Please consider each item carefully and record your ratings on the line in front.

Rating

1. _____ Gunner's seat.
2. _____ Gunner's hatch.
3. _____ Driver's seat.
4. _____ Driver's hatch.
5. _____ Commander's seat.
6. _____ Gunner's control locations.
7. _____ Gunner's control "Feel" (Sensitivity and response).
8. _____ Deadband in gunner's control.
9. _____ Someone else's seat/station blocks gunner.
10. _____ Placement of commo/radio gear.

11. _____ Placement of wiring.
12. _____ Ruggedness of wiring and hydraulics.
13. _____ Exposed hydraulic lines.
14. _____ Proximity switches on hatches.
15. _____ Usefulness of intercom equipment.
16. _____ Buttoned up visibility (Gunner's station).
17. _____ Boresighting procedures.
18. _____ Frequency that boresighting is required.
19. _____ Sharp equipment edges.
20. _____ Ease of raising launcher.
21. _____ Ease of stowing launcher.
22. _____ Ease of putting launcher in reload position.
23. _____ Light displays for launcher control.
24. _____ Machinegun stow.
25. _____ Turret fits ITV hull.
26. _____ Launcher has enough clearance outside.
27. _____ Gunner's station has enough clearance inside the ITV.
28. _____ Room with basic personal equipment on.
29. _____ Room when wearing web gear and winter clothing.
30. _____ Driver visibility buttoned up.
31. _____ Commander's viewing device (CVD)
32. _____ Equipment storage space.
33. _____ Center of gravity of the ITV.
34. _____ Space to perform job.

35. _____ Power of the ITV.
36. _____ Hill climbing ability of the ITV.
37. _____ Maneuverability of the ITV.
38. _____ Speed of ITV.
39. _____ Seats in crew compartment.
40. _____ Headgear in ITV.
41. _____ Engine access (from outside the ITV).
42. _____ Engine access (from inside).
43. _____ Launcher loading mechanisms.
44. _____ TOW missile stowage racks.
45. _____ TOW ground mount equipment stowage.
46. _____ Small arms stowage.
47. _____ Heater.
48. _____ Cargo hatch.
49. _____ Rear ramp.
50. _____ Vision blocks.
51. _____ Night vision capability.
52. _____ Batteries for night sight.
53. _____ Bottles for night sight.
54. _____ Daylight sights.
55. _____ Protection for sights.
56. _____ Night sight controls.
57. _____ Day sight controls.
58. _____ Cover lid on top of sights.

59. _____ Sturdiness of erection mechanism.
60. _____ Reliability of erection mechanism.
61. _____ Gunner's station blocks other crew members.
62. _____ Seat backs.
63. _____ Seat restraints.
64. _____ Track tension, after extended use.
65. _____ Suspension of the vehicle.
66. _____ Ventilation.
67. _____ Ability to use small arms from inside the vehicle.
68. _____ Ability to use the machinegun from the gunner's station.
69. _____ Inability to keep the 200 round ammo box on the machinegun when the turret is in use.
70. _____ Safety padding.
71. _____ ITV brakes.
72. _____ Driver's controls.
73. _____ Space large enough for large man.
74. _____ Small man as loader.
75. _____ Small man as gunner.

2
(76) Questionnaire Number

1
(77) Card Number

(78) ID Number

(79)

(80)

QUALITY OF DESIGN/REDESIGN REQUIREMENTS QUESTIONNAIRE
(CONTINUED)

1. _____ Refueling system.
2. _____ Ability to aid and move an injured crewmember.
3. _____ Places where rain water leaks in.
4. _____ Large man as loader.
5. _____ Large man as gunner.
6. _____ Personal gear placement in/on vehicle.
7. _____ Amount of power to drive the ITV turret.
8. _____ Lighting inside the ITV.
9. _____ Image transfer assembly (ITA).
10. _____ Backup power (and tracking).
11. _____ Design for operation in ice and snow.
12. _____ Design for operation in rain and mud.
13. _____ Design for operation in dust and dirt.
14. _____ Ability to estimate range while buttoned up.
15. _____ Knowing the elevation of launcher.
16. _____ Azimuth indicator.
17. _____ Frequency of required vehicle battery charges.
18. _____ High profile of the ITV.
19. _____ Circuit breakers.
20. _____ Possibility of damage to the missile guidance set (MGS).
21. _____ Fire interrupts.

22. _____ Communications wire and holder outside vehicle.
23. _____ Ability to camouflage the ITV.
24. _____ Small man as observer.
25. _____ Large man as observer.

2
(76) Questionnaire Number

2
(77) Card Number

(78) ID Number

(79)

(80)

SUGGESTIONS FOR CORRECTION

On the previous pages you were asked to rate the need for redesign of several features of the ITV. For each of the features of the ITV you rated a 5, Very Serious Problem, Please:

1. Write the number of the item on the list,
2. Write what the problem is, and
3. Briefly give your ideas about improving the situation.

If you need more paper, use the back of this and the other pages. If you wish to discuss your comments with someone, let the individual distributing this questionnaire know.

If the TC's seat was reversed (TC seated back to back with the driver) would the crew operate better? Why do you think so?

APPENDIX A - 4

Phase A, Post-training

Questionnaire on XM901 (ITV) Training

NAME _____

MOS _____

POSITION _____

Instructions: Since you have completed the training program, your answers will be of great value in helping us to improve the program.

Answer all questions that apply to the course material for which you have received training. Do not answer questions that apply to crew duties on the XM901 (ITV) for which you have not been trained.

Please take the time to write comments when you have noted problems or can make recommendations. This is important! Use the other side of the page if necessary.

If you have any problems filling out this questionnaire, raise your hand and the person administering the questionnaire will assist you.

1. The overall quality of training was:

Very Poor	Poor	Borderline	Good	Very Good
-----------	------	------------	------	-----------

2. The overall amount of training was:

Much Too Short	Too Short	Right Amount	Too Long	Much Too Long
----------------	-----------	--------------	----------	---------------

3. The student workload was:

Much Too Easy	Too Easy	Satisfactory	Too Hard	Much Too Hard
---------------	----------	--------------	----------	---------------

4. The learning objectives were:

Very Unclear	Unclear	Borderline	Clear	Very Clear
--------------	---------	------------	-------	------------

5. The student performance requirements were:

Very Unclear	Unclear	Borderline	Clear	Very Clear
--------------	---------	------------	-------	------------

6. The written training material was:

Very Poor	Poor	Borderline	Good	Very Good
-----------	------	------------	------	-----------

7. The organization of the course was:

Very Poor	Poor	Borderline	Good	Very Good
-----------	------	------------	------	-----------

8. The use of training aids was:

Very Poor	Poor	Borderline	Good	Very Good
-----------	------	------------	------	-----------

9. Teaching by the instructors was:

Very Poor	Poor	Borderline	Good	Very Good
--------------	------	------------	------	--------------

10. (a) Did you have difficulty hearing the instructor during some parts of the training program? (Circle One) YES NO

(b) If yes, when did this occur? _____

11. (a) Were there distractions during the training program that bothered you? (Circle One) YES NO

(b) If yes, what were they and when did they occur? _____

12. (a) Did you have difficulty following the instruction during some parts of the training program? (Circle One) YES NO

(b) If yes, what were the difficulties and when did they occur? _____

13. (a) Do you think the size of the student groups was right for training? (Circle One) YES NO

(b) If not, for what subjects and how would you change group size? _____

14. (a) Did you have any problems in learning the duties of your crew position? (Circle One) YES NO

(b) If yes, what were they? _____

15. (a) Did you have problems communicating or working together during crew activities? (Circle One) YES NO

(b) If yes, what were they? _____

16. (a) Were there problems in learning to acquire targets with the XM901? (Circle One) YES NO

(b) If yes, what were they? _____

(c) Any recommendations for correcting these problems? _____

17. (a) Were there problems in learning to track with the XM901? (Circle One) YES NO

(b) If yes, what were the problems? _____

(c) Any recommendations for correcting these problems? _____

18. Did the things you have learned to do in tracking with the ground mounted TOW make it harder or easier to learn to track with the XM901?

Much Harder	Somewhat Harder	No Effect	Somewhat Easier	Much Easier
-------------	-----------------	-----------	-----------------	-------------

19. Is it harder or easier to track with the ground mounted TOW after you have been tracking with the XM901?

Much Harder	Somewhat Harder	No Effect	Somewhat Easier	Much Easier
-------------	-----------------	-----------	-----------------	-------------

20. Compared with the ground mounted TOW, learning to track with the XM901 was:

Much Harder	Somewhat Harder	Borderline	Somewhat Easier	Much Easier
-------------	-----------------	------------	-----------------	-------------

21. Which was better for tracking a slow moving target?
(Circle One) XM901 Ground TOW

22. Which was better for tracking a fast moving target?
(Circle One) XM901 Ground TOW

23. (a) Did you get enough tracking practice with the XM901?
(Circle One) YES NO

(b) If not, how much more should you get?

- 2 times as much
- 3 times as much
- 4 times as much

24. (a) Did you get enough tracking practice with the Ground Mounted TOW? (Circle One) YES NO

(b) If not, how much more should you get?

- 2 times as much
- 3 times as much
- 4 times as much

25. (a) Were there problems in learning to determine range during the XM901 program? (Circle One) YES NO

(b) If yes, what were they? _____

26. What problems did you have learning night operations that have not been mentioned in answers to previous questions? _____

**For those who tracked with ITVETS:

Was it more difficult for you to track with the ITVETS (evasive target simulator) than with the target on the jeep?
(Circle One) YES NO

If yes, did the ITVETS increase tracking difficulty more for the ground mounted TOW or the XM901?
(Circle One) Ground TOW XM901

27. How difficult was it to learn the following parts of the XM901 Training Program?

	Very Difficult	Difficult	Borderline	Easy	Very Easy
--	----------------	-----------	------------	------	-----------

Locate and Name XM901 Subassemblies					
AN/TAS-4 Night Sight					
Combat Operational Checks					
Operator Maintenance					
Crew Drills					
Evacuation/Destruction Procedures					
Misfire Procedures					
Range Card/Vehicle Identification					
Training Equipment					
Target Engagement Techniques					
Tracking: Day					
Tracking: Night					
Remedial Training in Ground Mounted TOW					

28. The duration of the following parts of the XM901 Training Program was:

	Much Too Short	Too Short	Right Amount	Too Long	Much Too Long
Locate and Name XM901 Subassemblies					
AN/TAS-4 Night Sight					
Combat Operational Checks					
Operator Maintenance					
Crew Drills					
Evacuation/Destruction Procedures					
Misfire Procedures					
Range Card/Vehicle Identification					
Training Equipment					
Target Engagement Techniques					
Tracking: Day					
Tracking: Night					
Remedial Training in Ground Mounted TOW					

29. Hands-on experience for the following parts of the XM901 Training Program was:

	Much Too Short	Too Short	Right Duration	Too Long	Much Too Long
Locate and Name XM901 Subassemblies					
AN/TAS-4 Night Sight					
Combat Operational Checks					
Operator Maintenance					
Crew Drills					
Evacuation/Destruction Procedures					
Missfire Procedures					
Range Card/Vehicle Identification					
Training Equipment					
Target Engagement Techniques					
Tracking: Day					
Tracking: Night					
Remedial Training in Ground Mounted TOW					

30. Written material for the following parts of the XM901 Training Program was:

	Very Difficult to Understand	Difficult to Understand	Borderline	Easy to Understand	Very Easy to Understand
--	------------------------------	-------------------------	------------	--------------------	-------------------------

Locate and Name XM901 Subassemblies					
AN/TAS-4 Night Sight					
Combat Operational Checks					
Operator Maintenance					
Crew Drills					
Evacuation/Destruction Procedures					
Missfire Procedures					
Range Card/Vehicle Identification					
Training Equipment					
Target Engagement Techniques					
Tracking: Day					
Tracking: Night					
Remedial Training in Ground Mounted TOW					

31. Teaching by the instructor during the following parts of the XM901 Training Program was:

	Very Poor	Poor	Borderline	Good	Very Good
Locate and Name XM901 Subassemblies					
AN/TAS-4 Night Sight					
Combat Operational Checks					
Operator Maintenance					
Crew Drills					
Evacuation/Destruction Procedures					
Missfire Procedures					
Range Card/Vehicle Identification					
Training Equipment					
Target Engagement Techniques					
Tracking: Day					
Tracking: Night					
Remedial Training in Ground Mounted TOW					

32. Was enough information given to the student on how he was doing for each of the following parts of the XM901 Training Program?

	<u>YES</u>	<u>NO</u>
Locate and Name XM901 Subassemblies		
AN/TAS-4 Night Sight		
Combat Operational Checks		
Operator Maintenance		
Crew Drills		
Evacuation/Destruction Procedures		
Missfire Procedures		
Range Card/Vehicle Identification		
Training Equipment		
Target Engagement Techniques		
Tracking: Day		
Tracking: Night		
Remedial Training in Ground Mounted TOW		

33. Please give us recommendations for additions or changes you would make in the XM901 Training Program. _____

34. Any other comments relative to the XM901 Training Program?

APPENDIX A - 4

Phase B, Post-training

Questionnaire on XM901 (ITV) Training

NAME _____

MOS _____

POSITION _____

Instructions: Since you have completed the training program, your answers will be of great value in helping us to improve the program.

Answer all questions that apply to the course material for which you have received training. Do not answer questions that apply to crew duties on the XM901 (ITV) for which you have not been trained.

Please take the time to write comments when you have noted problems or can make recommendations. This is important! Use the other side of the page if necessary.

If you have any problems filling out this questionnaire, raise your hand and the person administering the questionnaire will assist you.

1. The overall quality of training was:

Very Poor	Poor	Borderline	Good	Very Good
-----------	------	------------	------	-----------

2. The overall amount of training was:

Much Too Short	Too Short	Right Amount	Too Long	Much Too Long
----------------	-----------	--------------	----------	---------------

3. The student workload was:

Much Too Easy	Too Easy	Satisfactory	Too Hard	Much Too Hard
---------------	----------	--------------	----------	---------------

4. The learning objectives were:

Very Unclear	Unclear	Borderline	Clear	Very Clear
--------------	---------	------------	-------	------------

5. The student performance requirements were:

Very Unclear	Unclear	Borderline	Clear	Very Clear
--------------	---------	------------	-------	------------

6. The written training material was:

Very Poor	Poor	Borderline	Good	Very Good
-----------	------	------------	------	-----------

7. The organization of the course was:

Very Poor	Poor	Borderline	Good	Very Good
-----------	------	------------	------	-----------

8. The use of training aids was:

Very Poor	Poor	Borderline	Good	Very Good
-----------	------	------------	------	-----------

8 a. Please note any suggestions you have for additions or improvements in training aids.

9. Teaching by the instructors was:

Very Poor	Poor	Borderline	Good	Very Good
--------------	------	------------	------	--------------

10. (a) Did you have difficulty hearing the instructor during some parts of the training program? (Circle One) YES NO

(b) If yes, when did this occur? _____

11. (a) Were there distractions during the training program that bothered you? (Circle One) YES NO

(b) If yes, what were they and when did they occur? _____

12. (a) Did you have difficulty following the instruction during some parts of the training program? (Circle One) YES NO

(b) If yes, what were the difficulties and when did they occur? _____

13. (a) Do you think the size of the student groups was right for training? (Circle One) YES NO

(b) If not, for what subjects and how would you change group size? _____

14. (a) Did you have any problems in learning the duties of your crew position? (Circle One) YES NO

(b) If yes, what were they? _____

15. (a) Did you have problems communicating or working together during crew activities? (Circle One) YES NO

(b) If yes, what were they? _____

16. (a) Were there problems in learning to acquire targets with the XM901? (Circle One) YES NO

(b) If yes, what were they? _____

(c) Any recommendations for correcting these problems? _____

17. (a) Were there problems in learning to track with the XM901? (Circle One) YES NO

(b) If yes, what were the problems? _____

(c) Any recommendations for correcting these problems? _____

18. Did the things you have learned to do in tracking with the ground mounted TOW make it harder or easier to learn to track with the XM901?

Much Harder	Somewhat Harder	No Effect	Somewhat Easier	Much Easier
-------------	-----------------	-----------	-----------------	-------------

19. Is it harder or easier to track with the ground mounted TOW after you have been tracking with the XM901?

Much Harder	Somewhat Harder	No Effect	Somewhat Easier	Much Easier
-------------	-----------------	-----------	-----------------	-------------

20. Compared with the ground mounted TOW, learning to track with the XM901 was:

Much Harder	Somewhat Harder	Borderline	Somewhat Easier	Much Easier
-------------	-----------------	------------	-----------------	-------------

21. Which was better for tracking a slow moving target?
(Circle One) XM901 Ground TOW

22. Which was better for tracking a fast moving target?
(Circle One) XM901 Ground TOW

23. (a) Did you get enough tracking practice with the XM901?
(Circle One) YES NO

(b) If not, how much more should you get?

_____ 2 times as much

_____ 3 times as much

_____ 4 times as much

24. (a) Did you get enough tracking practice with the Ground Mounted TOW? (Circle One) YES NO

(b) If not, how much more should you get?

_____ 2 times as much

_____ 3 times as much

_____ 4 times as much

25. (a) Were there problems in learning to determine range during the XM901 program? (Circle One) YES NO

(b) If yes, what were they? _____

26. What problems did you have learning night operations that have not been mentioned in answers to previous questions? _____

27. Was it more difficult for you to track with the ITVETS (evasive target simulator) than with the target on the jeep?

(Circle One) YES NO

28. Please list all of the things that made it easier and/or more difficult to track with ITVETS. _____

29. (a) Which is better for tracking practice?

(Circle One) ITVETS TARGET OR JEEP

(b) Why? _____

30. How difficult was it to learn the following parts of the XM901 Training Program?

	Very Difficult	Difficult	Borderline	Easy	Very Easy
Pre-operational checks on the AN/TAS-4					
Installation and Stowage of M220A1 Components on an XM901					
Pre-operational checks on the primary weapon system					
Troubleshooting the XM901 primary weapon system					
Bore sighting the Day sight/Tracker					
Bore sight alignment of the AN/TAS-4					
Placing the AN/TAS-4 into Operation					
Fire Command					
Reloading the Launcher					
Combat Misfire Procedures					
Dismounting and Assembling the M220A1					
Manual Erection of the XM901 Launcher					
Manual Target Acquisition and Engagement					
Evacuation of an XM901					
Stowing the XM901 Launcher					
Communications Training					

31. The duration of the following parts of the XM901 Training Program was:

	Much Too Short	Too Short	Right Amount	Too Long	Much Too Long
Pre-operational checks on the AN/TAS-4					
Installation and Stowage of M220A1 Components on an XM901					
Pre-operational checks on the primary weapon system					
Troubleshooting the XM901 primary weapon system					
Boresighting the Daysight/Tracker					
Boresight alignment of the AN/TAS-4					
Placing the AN/TAS-4 into Operation					
Fire Command					
Reloading the Launcher					
Combat Misfire Procedures					
Dismounting and Assembling the M220A1					
Manual Erection of the XM901 Launcher					
Manual Target Acquisition and Engagement					
Evacuation of an XM901					
Stowing the XM901 Launcher					
Communications Training					

32. Written material for the following parts of the XM901 Training Program was:

	Very Difficult to Understand	Difficult to Understand	Borderline	Easy to Understand	Very Easy to Understand
Pre-operational checks on the AN/TAS-4					
Installation and Stowage of M220A1 Components on an XM901					
Pre-operational checks on the primary weapon system					
Troubleshooting the XM901 primary weapon system					
Bore sighting the Daysight/Tracker					
Bore sight alignment of the AN/TAS-4					
Placing the AN/TAS-4 into Operation					
Fire Command					
Reloading the Launcher					
Combat Misfire Procedures					
Dismounting and Assembling the M220A1					
Manual Erection of the XM901 Launcher					
Manual Target Acquisition and Engagement					
Evacuation of an XM901					
Stowing the XM901 Launcher					
Communications Training					

33. Teaching by the instructor during the following parts of the XM901 Training Program was:

	Very Poor	Poor	Borderline	Good	Very Good
Pre-operational checks on the AN/TAS-4					
Installation and Stowage of M220A1 Components on an XM901					
Pre-operational checks on the primary weapon system					
Troubleshooting the XM901 primary weapon system					
Boresighting the Daysight/Tracker					
Boresight alignment of the AN/TAS-4					
Placing the AN/TAS-4 into Operation					
Fire Command					
Reloading the Launcher					
Combat Misfire Procedures					
Dismounting and Assembling the M220A1					
Manual Erection of the XM901 Launcher					
Manual Target Acquisition and Engagement					
Evacuation of an XM901					
Stowing the XM901 Launcher					
Communications Training					

34. Look at the list of tasks given in questions 29 through 32 and make recommendations for change in the way any of them are performed or taught. _____

35. Are there any other changes you would make in this training program? _____

POST OT III TRAINING EVALUATION

Now that you have had field experience with the ITV, you may have additional thoughts about training that will help us to bring about improvements in ITV training. Your answers and comments are important! If a question is not applicable to your crew position or unit write NA.

1. Squad Leaders or Gunners:

We wish to know if you received enough verbal explanation and practice during training (prior to the OT III test program) so that you could perform the following tasks as rapidly and accurately as you think you should during the test program.

For each of the following tasks, give the number of the answer that applies to the amount of verbal explanation needed and the amount of practice needed.

For OT III, I needed:

- 1 = much less than I received during training
- 2 = less
- 3 = right amount
- 4 = more
- 5 = much more

Squad Leader or Gunner: write NA if a task is not applicable to your duties during OT III

Verbal Explanation Practice

- 1) ITV site selection
- 2) Target Acquisition - day
- 3) Target Acquisition - night
- 4) Fire command, or passing target information from Squad Leader to Gunner
- 5) Accepting target information from outside observers or units
- 6) Target hand-off procedures between ITV's
- 7) ITV tracking - day
- 8) ITV tracking - night
- 9) ITV tracking when ITV is on an incline

	<u>Verbal Explanation</u>	<u>Practice</u>
10) Use of M60 machine gun		
11) Use of Commander's Viewing Device		
12) Tactical procedures with ITV		
13) Control of ITV operations		

List other tasks performed during OT III and the amount and kind of training needed.

2. Squad Leaders or Gunners:

We wish to know if you received enough verbal explanation and practice during training so that you could perform the following tasks as rapidly and accurately as you think you should during combat.

For Combat, I will need:

- 1 = much less than I received during training
- 2 = less
- 3 = right amount
- 4 = more
- 5 = much more

Squad Leader or Gunner: write NA if a task is not applicable to your duties during combat.

	<u>Verbal Explanation</u>	<u>Practice</u>
1) ITV site selection		
2) Target Acquisition - day		
3) Target Acquisition - night		
4) Fire command, or passing target information from Squad Leader to Gunner		
5) Accepting target information from outside observers or units		

	<u>Verbal Explanation</u>	<u>Practice</u>
6) Target hand-off procedures between ITV's		
7) ITV tracking - day		
8) ITV tracking - night		
9) ITV tracking when ITV is on an incline		
10) Use of M60 machine gun		
11) Use of Commander's Viewing Device		
12) Tactical procedures with ITV		
13) Control of ITV operations		
14) Map reading		
15) Range Determination		

List other tasks you would perform during combat and the amount and kind of training needed.

3. All Crew Members:

We wish to know if you received enough verbal explanation and practice during training (prior to the OT III test program) so that you could perform the following tasks as rapidly and accurately as you think you should during the test program.

For each of the following tasks, give the number of the answer that applies to the amount of verbal explanation needed and the amount of practice needed.

For OT III, I needed:

- 1 = much less than I received during training
- 2 = less
- 3 = right amount
- 4 = more
- 5 = much more

All crew members: write NA if a task is not applicable to your duties during OT III

	<u>Verbal Explanation</u>	<u>Practice</u>
1) Preoperational checkout	_____	_____
2) Emplacement of ITV	_____	_____
3) Displace and move out	_____	_____
4) Dismounting TOW from ITV	_____	_____
5) Installing TOW on ITV	_____	_____
6) Installation of night sight and collimator	_____	_____
7) Boresighting of day sight	_____	_____
8) Boresighting of night sight	_____	_____
9) Reloading at night	_____	_____
10) Reloading when ITV is on an incline	_____	_____
11) Manual acquisition and engagement	_____	_____
12) Misfire procedures	_____	_____
13) Procedures for use of radio	_____	_____
14) Procedures for use of intercom	_____	_____
15) Use of backup signals when communication system is not working	_____	_____
16) Troubleshooting	_____	_____
17) Stowage procedures	_____	_____
18) Crew operations with loaded vehicle	_____	_____
19) Evacuation	_____	_____
20) Standard Operating Procedures (SOP's) for specific situations	_____	_____

List other tasks performed during OT III and the amount and kind of training needed.

4. All Crew Members:

We wish to know if you received enough verbal explanation and practice during training so that you could perform the following tasks as rapidly and accurately as you think you should during combat.

For Combat I will need:

- 1 = much less than I received during training
- 2 = less
- 3 = right amount
- 4 = more
- 5 = much more

All crew members: write NA if a task is not applicable to your duties during combat,

- 1) Preoperational checkout
- 2) Emplacement of ITV
- 3) Displace and move out
- 4) Dismounting TOW from ITV
- 5) Installing TOW on ITV
- 6) Installation of night sight and collimator
- 7) Boresighting of day sight
- 8) Boresighting of night sight
- 9) Reloading at night
- 10) Reloading when ITV is on an incline
- 11) Manual acquisition and engagement
- 12) Misfire procedures

	Verbal Explanation	Practice
1)		
2)		
3)		
4)		
5)		
6)		
7)		
8)		
9)		
10)		
11)		
12)		

	<u>Verbal Explanation</u>	<u>Practice</u>
13) Procedures for use of radio	_____	_____
14) Procedures for use of intercom	_____	_____
15) Use of backup signals when communication system is not working	_____	_____
16) Troubleshooting	_____	_____
17) Stowage procedures	_____	_____
18) Crew operations with loaded vehicle	_____	_____
19) Evacuation	_____	_____
20) Standard Operating Procedures (SOP's) for specific situations	_____	_____
21) Camouflage techniques	_____	_____
22) Vehicle identification	_____	_____

List other tasks you would perform during Combat and the amount and kind of training needed.

5. Squad Leaders and Gunners:
How often should you practice tracking with the ITV to maintain proficiency?

Circle one:

1 hour every: a) 3 days b) week c) 2 weeks d) 4 weeks

6. All crew members:
How often should you practice tracking on the Ground TOW to maintain proficiency?

Circle one:

1 hour every: a) 3 days b) week c) 2 weeks d) 4 weeks

7. All crew members:

How often should you practice crew drills to maintain proficiency?

Circle one:

1/2 day every: a) 3 days b) week c) 2 weeks d) 4 weeks

Squad Leaders and Gunners (8 & 9):

8. Which method of tracking practice helped you more to be able to track the Manned Evasive Target Tanks?

Circle one: Target Board ITVETS

In Jeep

9. Which method would help you more if the ITVETS scoring was the same as the Target Board In Jeep.

Circle one: Target Board ITVETS

In Jeep

Squad Leaders only (10 & 11):

10. Should you be trained with your squad or should you have been trained before your squad and then help with their training?

Circle one: Train with Squad Train before squad

11. Should you have been trained on how the vehicle works (similar to organizational maintenance training)?

Circle one: Yes No

All crew members:

12. Please write any comments you have about how well the training program prepared you for the OT III test program. Use other side of page if necessary.

APPENDIX A - 5

ITV OT III BIAS EVALUATION

NAME _____ DATE _____

ITV RATINGS

Please rate how good you feel that the XM901 - ITV is on the following several things. In deciding your ratings please consider how well you think the ITV would perform in combat, based upon your experiences in this test program.

For each statement below please select one of the following five answers.

1 = Very Good

2 = Good

3 = Fair

4 = Poor

5 = Very Poor

Please mark your answer choice (1, 2, 3, 4, or 5) on the line in front of each statement below.

MEAN

1. 3.3 Ruggedness of the ITV.
2. 3.5 Reliability of the ITV.
3. 3.0 Vulnerability of the ITV.
4. 2.4 Crew protection from enemy action.
5. 2.4 Safety of operation (do not consider enemy action).
6. 3.6 Storage capacity.
7. 3.6 Crew working space.
8. 2.4 Ability to detect targets.
9. 2.2 Ability to identify targets.

MEAN

10. 1.9 Ability to track targets.
11. 2.1 Ability to hit targets.
12. 2.0 Ability to use secondary armament.
13. 2.3 Ability to set up quickly to fire.
14. 2.3 Ability to stow launcher and depart firing area quickly.
15. 2.4 Ability to reload quickly.
16. 2.9 Overall design for crew member ease of use of the ITV.
17. 3.1 Taking all of the above points into account (plus any other features you feel are important) please give an overall rating of the ITV as a weapon system for combat use.
18. 2.6 Taking all important factors into account please give an overall rating of the M113/ground launched TOW as a weapon system for combat use.

The following questions are included to determine your general feelings about the ITV and the ITV test program.

19. Overall, what is your current opinion of the ITV?

1. Like it very much
2. Like it
3. Like it slightly ← Average Rating was 3.3
4. Neither like nor dislike it
5. Dislike it slightly
6. Dislike it
7. Dislike it very much

20. How important do you feel the ITV operational test is?

1. Very important
 2. Important ← Average Rating was 1.8
 3. Somewhat important
 4. Neither important nor unimportant
 5. Somewhat unimportant
 6. Unimportant
 7. Very unimportant
21. How do you feel about being a part of the ITV test program?
1. Very much like being part of the test
 2. Like being part of the test ← Average Rating was 2.8
 3. Somewhat like being part of the test
 4. Neither like nor dislike being part of the test
 5. Somewhat dislike being part of the test
 6. Dislike being part of the test
 7. Very much dislike being part of the test

APPENDIX B



DEPARTMENT OF THE ARMY
ARI FIELD UNIT, BENNING
U. S. ARMY RESEARCH INSTITUTE FOR THE BEHAVIORAL AND SOCIAL SCIENCES
P.O. BOX 2086, FORT BENNING, GEORGIA 31905
Mr.Thompson/gb/5-1414

PERI-OB

24 April 1978

MEMORANDUM THRU: CHIEF, ARI-BENNING
FOR: COL WILLYS E. DAVIS, TSM, ITV, ATSH-TSM-TV
SUBJECT: Reversal of ITV Commander's Vision Device (CVD) Position.

1. The Commander's Vision Device (CVD) represents, to Army Research Institute observers, an effort to solve the command and control conflict presented to the Improved TOW Vehicle (ITV) commander. The commander, a squad or section leader, must perform his duties of controlling one or two vehicles which would normally call for him to be positioned where best observation is possible. This is usually in the vehicle turret. The ITV crew includes a gunner who by duty assignment must occupy the turret seat to carry out target engagement activities. The squad leader remains responsible for the crew's performance and should have access to as much information critical to performance as possible. The ITV is not configured to ease the squad leader's performance of command and control functions and permit the gunner to perform his duties simultaneously.
2. Experimentation with crew positions, doctrine, and viewing device improvements has resulted in the current ITV configuration which is, at best, a compromise. The leader may effectively control the crew(s) from a dismounted remote position affording good fields of view while the section is emplaced. During travel the leader can navigate and control most successfully from the gunner's station by standing on the seat in the turret. He can not function in the open cargo hatch while traveling as has been attempted in field experiments. When the vehicle is emplaced or is in overwatch buttoned up, the squad leader using the CVD has limited field of view and difficulty detecting, identifying and prioritizing targets for the gunner. The vehicle configuration and the internal as well as external space limitations which must be considered in positioning the CVD pose a problem. Reversing the seating position of the squad leader improves a difficult situation. Squad leaders at the ITV OT III test site expressed support for the idea of reversing the seat. Crews in general supported the idea with the exception of the drivers. The drivers viewed a fixed seat back to back with their own as hazardous to their exiting to the rear of

PERI-OB

24 April 1978

SUBJECT: Reversal of ITV Commander's Vision Device (CVD) Position.

the vehicle in an emergency. A design proposal later will address this (4.c.). The following recommendations are based on observations by ARI personnel and test subjects and equipment limitations noted on the current vehicle configuration.

3. Changes in the CVD:

a. Increase the horizontal field of view to at least 25 degrees from its present 12.5 degrees. This will match the field of view of the gunner when he is using the wide view lens. Do not change the magnification power of the device since this is presently adequate. Dual power 3X and 13X would of course be better. The increased field of view would provide the squad leader with target detection and acquisition capabilities he must have. He should be establishing target priorities for the gunner and with a narrow field of view this is an extremely difficult task. Being limited to fields of view not masked by deck mounted equipment and the turret is bad enough. Were bulk not a consideration, dual power 3X and 13X capability would be useful.

b. The CVD is now limited to elevation adjustments of +10° and -20°. The launcher assembly may move between +38° and -31° in some directions before fire interrupt lights are activated by electrical limit switches. Should the ITV be parked on an incline and canted, firing over the top of covering terrain, it is possible that the CVD would only show views of sky. The vehicle commander as a result of the CVD elevation limits and the nature of the terrain being occupied could be forced to select a less favorable firing site (less vehicular protection) to gain an adequate view of the battlefield.

c. Add thermal night viewing capabilities to the CVD unit itself. The device, and therefore, a squad leader at his station are ineffective during darkness. The bulk of a night sight would have to be built into the portion of the CVD located inside the vehicle hull to keep from obstructing turret movement. System internal battery power should only be considered as an emergency energy source since available power is already over-taxed.

d. An illumination device for the CVD azimuth indicator at night would be useful. Currently, it is not possible to read the azimuth indicator in the CVD even when targets are receiving external illumination.

e. The viewing angle of the CVD eyepiece should be changed to fit a reversed seating position for the vehicle commander. Adjustments to control positions may also be necessary.

4. Reverse the seat position for the leader so that his back is against that of the driver and adjust the viewing angle of the CVD accordingly.

PERI-OB

24 April 1978

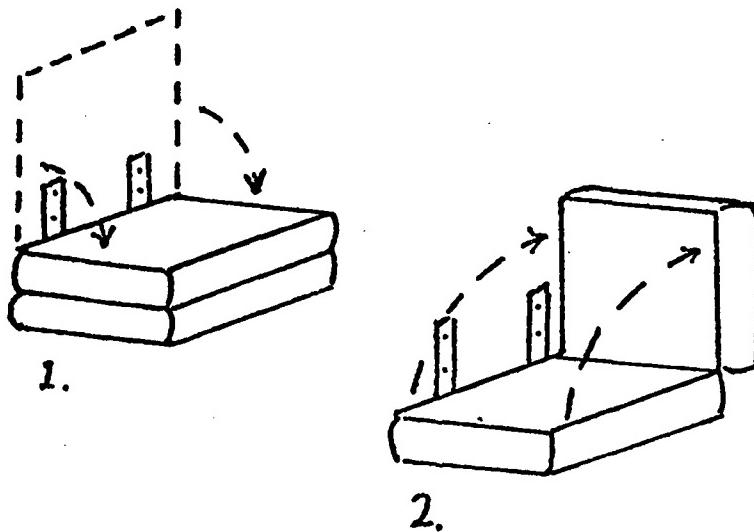
SUBJECT: Reversal of ITV Commander's Vision Device (CVD) Position.

It is felt that he will not lose directional orientation in this position and there are several advantages to this seating arrangement at his station. Testing ITV's with reversed seats would reveal any orientation problems.

a. The squad leader's body mass will be moved away from the traversing turret which has to date caused problems. When winter clothing and/or load bearing equipment is worn it gets caught easily on projections from the turret. A leg guard may be added to the turret lower assembly to prevent the squad leader's legs and feet from becoming tangled and possibly injured by turret rotation.

b. The leader can exit to the rear of the vehicle more easily if he faces in that direction. Presently, he must pull himself up into a cramped position to remove his feet and then back out of the seat. He may also lean back and crab crawl out if he chooses.

c. A double folding seat would be helpful to conserve space and ease driver entry/exit through the crew compartment.



PERI-OB

24 April 1978

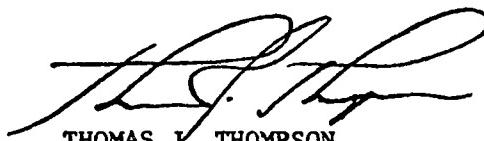
SUBJECT: Reversal of ITV Commander's Vision Device (CVD) Position.

d. The position reversal could not affect the leader's ability to navigate. The CVD can not be effectively or safely used while the vehicle is in motion. The rear compartment can not be used either with the launcher stowed. The squad leader must travel "heads up" in the turret.

e. Facing to the rear would improve the squad leader's control of the gunner and loader. In the event of intercommunication system failure the squad leader would be facing the gunner and would be better able to direct his actions. He would also be able to assign observation sectors more effectively to the loader and monitor all internal activity.

f. Orientation of the leader inside the vehicle to the outside is of little concern. If the seat is reversed he is physically oriented to his squad. His observation device (CVD) has an azimuth indicator allowing him to orient observation to the gunner's acquisitions and establish target priorities.

g. Seat reversal would give the squad leader easy access to the vehicular radios. Squad leaders have noted difficulty in using communication equipment with the present squad leader's station configuration.



THOMAS J. THOMPSON
Research Psychologist

CF: Dr. Smith



APPENDIX C

DEPARTMENT OF THE ARMY

ARI FIELD UNIT, BENNING

U. S. ARMY RESEARCH INSTITUTE FOR THE BEHAVIORAL AND SOCIAL SCIENCES
P.O. BOX 2086, FORT BENNING, GEORGIA 31905

Mr.Thompson/gb/5-1414

PERI-OB

15 May 1978

MEMORANDUM THRU: CHIEF, ARI FIELD UNIT-BENNING
FOR: COL WILLYS E. DAVIS, TSM, ITV, ATSH-TSM-TV
SUBJECT: The Evasive Target Simulator (ETS).

1. The ETS has received trial use at both the ITV DT III and OT III test sites. The training device received more extensive use at the OT III site, Yakima Firing Center, during Phase B training in January, 1978. The infantry crews conducted ground mounted TOW refresher training using the device but qualification tables were conducted using the jeep mounted target source. Crew members have had varying degrees of prior experience with TOW which makes it difficult to provide reliable data on the value of the ETS as a training device. Data collected from the two cavalry crews during Phase B provide some evidence of the utility of the ETS.
2. One cavalry crew returned to the test after more than three months (6 October - 16 January) delay in the test. They received refresher tracking training on the ITV using the ETS. The second crew was new to the ITV and TOW in general. They received the same tracking practice using the ETS as did the experienced crew. The one difference in the tracking experience during training was that only the returning crew was given a pretraining tracking qualification test (see figure 1.). Both crews were given a post training qualification test using the M70 jeep mounted target board as were the infantry crews. The two cavalry crews qualified comparably (see Figure 1.) indicating that the ETS is as useful a tracking training device for inexperienced ITV gunners as it is for refresher training.
3. While the cavalry crews used the ETS for training and then qualified using the M70 jeep mounted target source, the infantry crews conducted both the refresher training and qualification using the M70 jeep source. A direct comparison between infantry and cavalry training thus lacks total validity due to these differences. The infantry, it could be assumed, ought to qualify better against the M70 jeep because their practice used the M70 jeep too. In addition, the infantry had ground

PERI-OB

15 May 1978

SUBJECT: The Evasive Target Simulator (ETS).

mounted TOW refresher training using the ETS. However, the infantry and the cavalry qualified comparably which indicates that the ETS can train to M70 jeep mounted target system standards (see Figure 2.).

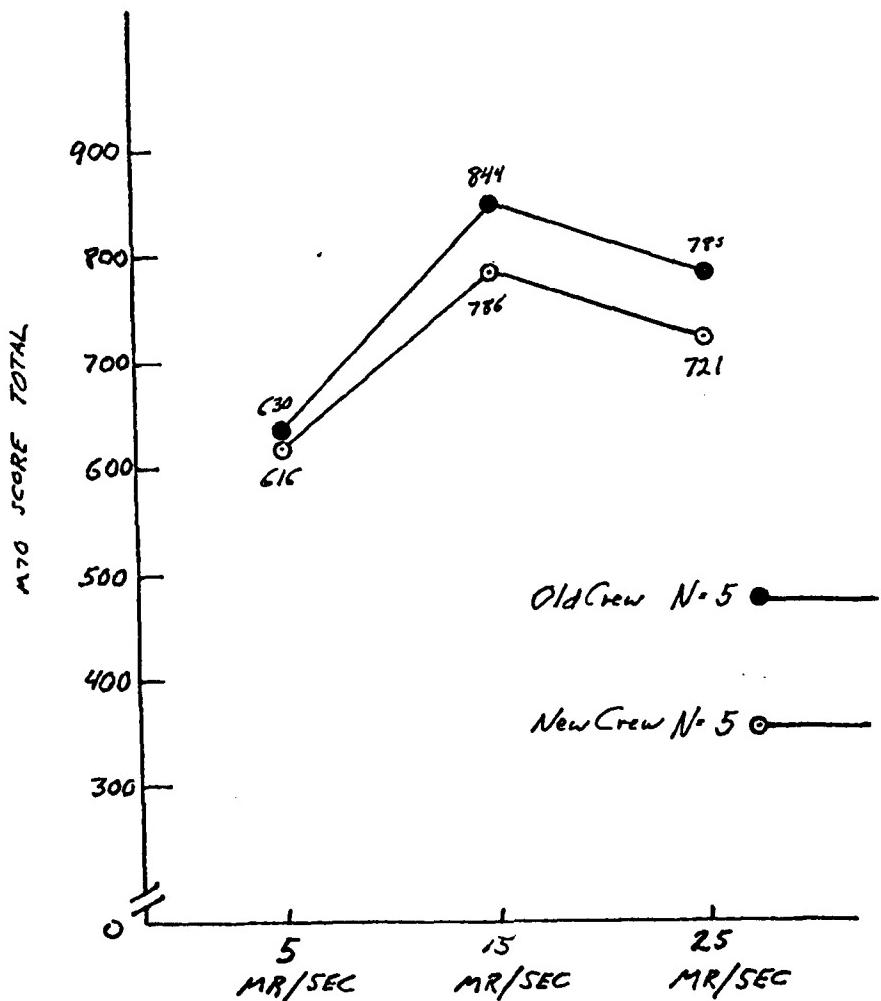


Figure 1. Phase B, OT III, Cavalry Training Qualification Scores.

PERI-OB

SUBJECT: The Evasive Target Simulator (ETS).

15 May 1978

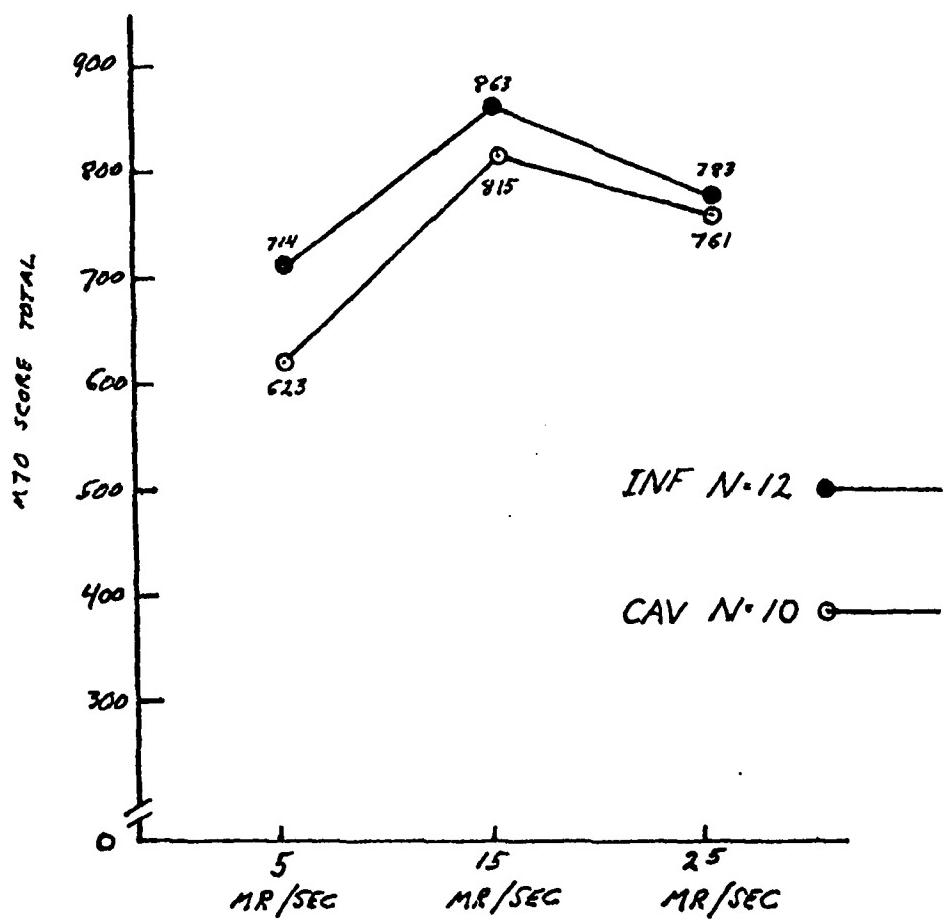


Figure 2. Cavalry and Infantry Post Training Qualification Scores (M70)

PERI-OB

15 May 1978

SUBJECT: The Evasive Target Simulator (ETS).

4. The crews at OT III, Phase B, were given post training interviews and questionnaires. The crew members, cavalry and infantry, were split evenly in their preference for the ETS and the M70 jeep mounted target. It was recognized that the ETS light source was more difficult to register on the MGS. The summary of comments made during interviews includes:

a. Unfavorable

- (1) It is too hard to score. If you get a zero it bothers you, and you don't really know how far off you were.
- (2) The ETS does not act like a vehicle. You do not have the same feeling as when tracking the jeep that is moving over the ground.
- (3) He could not see the target clearly because it was too small and the lighting was not good enough.
- (4) The ETS had a jerky motion in certain parts of its travel.
- (5) The rate of motion did not seem to be calibrated accurately. The slow rate (Task A) seemed much slower than Task A with the jeep.
- (6) The target motion was jerky at certain points.
- (7) While tracking the slow target during Task A it was possible to track in a straight line. While tracking the fast target during Task C it was necessary to track while the target changed direction.

b. Favorable

- (1) The close tolerance limits made the gunner more determined and accurate in his tracking.
- (2) The gunner learned to try harder and to concentrate.
- (3) The gunner was not bothered by the low scores because they had not developed a standardized scoring system yet.
- (4) The gunner was always able to keep the target within his field of view even though he didn't score very high.
- (5) Practice with the ETS must have helped because he scored expert on all 3 tasks with the Ground TOW. This is the first time he has ever done this. But the ETS has some bugs in it. It was hard to see and it had a jerky motion at certain times.

PERI-OB

15 May 1978

SUBJECT: The Evasive Target Simulator (ETS).

(6) Once the gunner got on the firing line he realized how much the ETS had helped.

(7) The big target board (M70) was much easier after the ETS.

5. The ETS, in some configuration, should be considered for further testing and development. The present model may be more expensive to procure than is necessary. The sophistication present in the current ETS may also be unnecessary. The system provides the commander or training cadre with added abilities they presently lack. Given a functional ETS the ITV, or ground mounted TOW crew can:

a. Conduct tracking practice in limited space areas such as motor pool or company areas. The requirement of range facilities and a committed target board mounted vehicle would no longer be necessary.

b. Related to a. above, is the freedom to use any time for training and not be limited to scheduled range hours.

c. The ETS is capable of operating in more than one mode. The device can provide a laterally moving target with variations in speed. It can also provide practice in evasive mode tracking, the mode most likely to be encountered in combat.

6. Further advantages of using the ETS will be known only after additional testing and refinement. The current model was difficult to compare to the M70 tracking system due to the sensitivity of the infrared light source it uses. Scoring discrepancies between the two systems resulted. Gunner attitudes are, in part, related to how well they score on qualification tracks. Improvements in scoring characteristics would in all probability be fairly easy to accomplish and would greatly increase gunner support for the ETS.

7. Army Research Institute researchers, in examining the data from ITV DT III and ITV OT III, strongly endorse the continued development of the ETS. It is expected that as a training device it will have utility in initial TOW and ITV training programs and certainly enhance the refresher tracking training in units where training time and facilities are at a premium.



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Research Psychologist

APPENDIX D

TASK REPORT

ITV TRAINING EVALUATION AND RECOMMENDATIONS

Wilbur C. Middleton, PhD.

Prepared for the
Army Research Institute for
the Behavioral and Social Sciences
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June 1978



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FOREWORD

The Army Research Institute (ARI) is responsible for this report which presents an independent evaluation of the training provided to test subject personnel for participation in the DT III and OT III evaluations of the Improved TOW Vehicle (ITV). The training is evaluated in terms of crew member performance, questionnaire responses and interview comments. The performance data were made available for this evaluation by the test directorates for the DT III and OT III programs. Data and observations from the questionnaires and interviews were obtained by ARI representatives and were submitted to the respective test directorates during the course of the test programs. A summary of the data and observations is presented in this report, with the exception that specific interview comments are included when they appear to be significant or represent the view of a number of personnel. The training results are summarized at the end of the report by responding to key training issues which are identified at the beginning of the report. The most significant findings are included in an executive summary.

Dr. Middleton conducted his research and data collection activities while consulting for Litton Mellonics Systems Development Division. Dr. Middleton participated in a final phase of data collection and produced this report while employed by the U. S. Army Operational Test and Evaluation Agency (OTEA). Litton Mellonics wishes to thank OTEA for granting time to this effort and Dr. Middleton for his extended participation.

<u>ITV TRAINING EVALUATION AND RECOMMENDATIONS</u>	
<u>1. INTRODUCTION</u>	Page 143
<u>2. METHOD</u>	144
<u>2.1 KEY TRAINING ISSUES</u>	144
<u>2.2 PROGRAMS OF INSTRUCTION</u>	145
<u>2.2.1 Mechanized Infantry Gunner and Crew Training</u>	145
<u>2.2.2 Cavalry Gunner and Crew Training</u>	150
<u>2.2.3 Airborne Infantry ITV Familiarization and Tracking Training</u>	151
<u>2.3 DATA SOURCES AND INSTRUMENTS</u>	151
<u>2.3.1 Training Questionnaire Development</u>	154
<u>2.3.2 Training Interview Format</u>	154
<u>3. RESULTS</u>	155
<u>3.1 OT III TRAINING DATA AND OBSERVATIONS - PHASE A</u>	155
<u>3.1.1 Infantry Training Data</u>	155
<u>3.1.2 Infantry Responses to the Post Training Questionnaire</u>	160
<u>3.1.3 Infantry Responses to the Post Training Interview</u>	163
<u>3.1.4 Cavalry Training Data</u>	183
<u>3.1.5 Cavalry Responses to the Post Training Questionnaire</u>	183
<u>3.1.6 Cavalry Responses to the Post Training Interview</u>	185
<u>3.1.7 Comparison of Basic Training and the Results of This Training for the Infantry and the Cavalry Programs</u>	187
<u>3.2 OT III TRAINING DATA AND OBSERVATIONS - PHASE B</u>	190
<u>3.2.1 Evaluation of Test Subjects' Bias Toward the ITV and the OT III Test Program</u>	190
<u>3.2.1.1 Ratings of the ITV and the Test Program by Infantry Test Subjects</u>	190
<u>3.2.1.2 Ratings of the ITV and the Test Program by Cavalry Test Subjects</u>	191
<u>3.2.2 Infantry Training Data</u>	191
<u>3.2.2.1 Pre-training Data</u>	191
<u>3.2.2.2 Post-training Data</u>	192

	Page
<u>3.2.3 Infantry Questionnaire Data and Observations on Phase B Training and Comparison with Similar Data on Phase A.</u>	192
<u>3.2.4 Cavalry Training performance Data</u>	204
<u>3.2.4.1 Pre-training Data</u>	204
<u>3.2.4.2 Post-training Data</u>	205
<u>3.2.5 Cavalry Questionnaire Data and Observations on Phase B Training and Comparison with Similar Data on Phase A.</u>	205
<u>3.3 OT III POST TEST TRAINING ASSESSMENT</u>	206
<u>3.3.1 Gunner Qualification Scores</u>	206
<u>3.3.2 Post Test Training Questionnaire</u>	208
<u>3.4 DT III TRAINING DATA AND OBSERVATIONS</u>	210
<u>3.4.1 Training Performance Data</u>	210
<u>3.4.2 Responses to the Post Training Questionnaire</u>	211
<u>3.4.3 Responses to the Post Training Interview</u>	213
<u>4. SUMMARY OF RESULTS</u>	218

LIST OF TABLES

	<u>Page</u>
Table 1. Training Schedule, OT III Infantry Phase A	146
2. Training Schedule, OT III Infantry Phase B	148
3. Training Schedule, OT III Cavalry Phase A	152
4. Training Schedule, OT III Cavalry Phase B	153
5. Gunner Qualification Scores, OT III Infantry Phase A	157
6. Comparison of Qualification Scores, OT III Infantry Phase A .	158
7. Performance Scores--Post Training, OT III Infantry Phase A ..	159
8. Qualification and Performance Results--Post Training, OT III Cavalry Phase A	184
9. Qualification Scores--Pre Training, OT III Infantry Phase B .	193
10. Performance Scores--Pre-Training, OT III Infantry Phase B ...	194
11. Qualification Scores--Post-Training, OT III Infantry Phase B	195
12. Performance Scores--Post Training, OT III Infantry Phase B ..	196
13. Pre- and Post-Training Data, OT III Cavalry Phase B	207
14. DT III and OT III (Prior TOW Experience) ITV Mean Qualification Scores	210
15. Prior TOW Experience, DT III	211

EXECUTIVE SUMMARY

The Army Research Institute conducted an independent evaluation of the training provided to personnel for participation in the DT III and OT III evaluations of the Improved TOW Vehicle (ITV). The results are summarized in terms of responses to key training issues which were identified in the test plans for the DT III and OT III programs. Primary attention was given to the OT III training program, with inclusion of DT III results when they contribute to a particular training issue. The following results were obtained:

1. ITV training for OT III was found to be adequate for new equipment training. Specific suggestions are made for improvement based primarily on test subject comments. The primary training deficiencies pertained to operational use of the ITV. Operational training would normally occur in the home unit or in special courses. The training deficiencies were alleviated during pilot testing and during field test exercises so that the troops were adequately prepared for the test program.
2. Basic institutional ITV training can be accomplished in four 8-hour days with troops which have Ground TOW experience, assuming an ITV is available for each squad. Remedial Ground TOW training is recommended for representative troops. In addition, limited operational training is recommended in the institutional setting to add meaning to the basic instruction and promote greater retention. The following 10-day program is recommended:

a) Remedial TOW training	2 days
b) Basic ITV training	4 days
c) Crew performance testing and firing qualification	1 day
d) Tactics training and operational experience	3 days

At least one extra day of instruction would be required for troops without Ground TOW experience. The average ITV firing qualification level of these troops at the end of training would be lower than that of experienced troops unless effective selection criteria are developed.

3. OT III training data indicate that any effects of negative transfer which may have occurred between gunner training for the Ground TOW and for the ITV were overshadowed by positive transfer and by practice effects. Gunners who thought their Ground TOW experience had negative effects stated that these effects disappeared during the early stages of ITV training. A comparison of ITV tracking scores for TOW experienced Infantry squad leaders and gunners with tracking scores for non-experienced Cavalry crewmen indicates that positive transfer occurred; although, the superior performance of the Infantry could also be due to selection. The majority of gunners indicated they would have no trouble going back and forth between the Ground TOW and the ITV if they could continue to practice enough to maintain proficiency on both.

4. A significant drop in ITV tracking skills was found after a 3½ month break between Phase A and Phase B training and between Phase B training and the end of the test program. The long term retention of tracking skills with the ITV was found to be significantly lower than with the Ground TOW. This could be due to the greater complexity of ITV tracking and/or to the relative recency of ITV training without opportunity for periodic reinforcement. The test program data supports the need for more frequent training at the home base than now occurs to maintain TOW and ITV proficiency.

5. ITV tracking training with both the M70 Jeep mounted target board (Infantry) and the Evasive Target Simulator (Cavalry) resulted in a performance effectiveness of approximately 90% against Manned Evasive Target Tanks. The majority of gunners thought both training systems should be used to provide different kinds of practice. The M70 Jeep provides practice in tracking a real vehicle, while the ETS can provide readily available practice on an evasive target.

1. INTRODUCTION

The purpose of this training evaluation is to provide an independent assessment of the instruction and methods of training for the operation of the Improved TOW Vehicle (ITV). Key training issues are identified and answers are presented.

The following training programs are evaluated:

- 1) Mechanized Infantry Gunner and Crew Training.
This program was conducted at the Yakima Firing Center by the United States Army Infantry School in support of the OT III evaluation of the ITV. The program of instruction included basic training in the operation and firing of both the ITV and the Ground TOW.
- 2) Cavalry Gunner and Crew Training.
This program was conducted at the Yakima Firing Center by the United States Army Armor School in support of the OT III evaluation of the ITV. The program of instruction included basic training in the operation and firing of the ITV without Ground TOW equipment.
- 3) Mechanized Infantry ITV Familiarization and Tracking Training.
The familiarization program was conducted at the White Sands Missile Range by the United States Army Infantry School in support of the DT III evaluation of the ITV. The tracking training was conducted as part of the DT III Test Program. One objective of the DT III program was to evaluate the development of firing skills under controlled conditions. This data is essential in providing answers to some of the key training issues.

This training evaluation has not been established to monitor training and determine that test troops are ready for participation in the test programs. This responsibility has been assigned to other agencies to support program decisions. By the same token, data collected by other agencies will be utilized for the purposes of this evaluation.

The advantages of this independent approach to the evaluation of ITV training are:

- 1) An objective view of ITV training can be obtained because the project staff are not directly involved in the development or administration of ITV training for either the DT III or OT III programs.
- 2) The training and subsequent crew performance activities can be observed during both the DT III and OT III programs, and the results can be compared and integrated into one final report with recommendations for ITV training.

2. METHOD

The major questions to be answered with respect to ITV training are identified as key training issues. The three training programs which will be evaluated are described. Data sources and data collection instruments are then identified or developed to provide answers to the key training issues.

2.1 KEY TRAINING ISSUES

The key ITV training issues have been identified in the program plans for DT III and OT III. Neither test program provides crucial information relevant to all of the key training issues identified in the plans for that program because of constraints imposed by other factors in the program plan. Information from both test programs and information obtained during this independent evaluation must be combined to provide an adequate answer to many of the training issues.

The following list of training issues has been consolidated from the program plans for the two test programs:

- 1) Is the ITV training program adequate for new equipment training?
Data and observations should include the following factors:
 - a) instruction
 - b) methods of training
 - c) training aids: availability, suitability, and adequacy
 - d) training literature: clarity, accuracy, completeness and adequacy
 - e) performance of test subjects at end of training
 - f) performance of test subjects during and at the end of the test programs
- 2) What is the length of time required to train an ITV crew with and without Ground TOW experience?
Is this time significantly greater than that for Ground TOW training?
Instructor and equipment availability must be considered in estimates of required training time.
- 3) What are the effects of transfer of training between the Ground TOW and the ITV?
Can a gunner maintain tracking proficiency on both the Ground TOW and the ITV?
- 4) What is the long-term retention of ITV tracking skills as measured periodically during the test program after training?
- 5) How adequate is the M-70 training system with target mounted on Jeep and how adequate is the ITVETS for training gunners to hit real targets which move evasively?

2.2 PROGRAMS OF INSTRUCTION

2.2.1 Mechanized Infantry Gunner and Crew Training for OT III

This program was conducted at the Yakima Firing Center by the United States Army Infantry School in two phases, Phase A and Phase B. The program of instruction for both phases included basic training in the operation and firing of the ITV and the Ground TOW. Subsequent to Phase A, 3 days of tactical training were conducted.

The test personnel were to be 6 established TOW crews from CSC, 2-60 Infantry Battalion, 9th Infantry Division. This objective was not completely fulfilled. Many of the men in the 6 crews had not worked together previously within the same crews. Their TOW experience varied from 4 months to over 2 years.

Phase A consisted of 10 days of training and testing, which were conducted during the period 17-30 August, 1977. The instruction was given by 6 enlisted men and an officer. The lesson schedule is shown in Table 1. Sixty hours of training were scheduled during 7 days. In addition, 20 hours of pre and post testing were administered during 3 days. Six 4-man crews were trained with 3 ITV's. However, due to maintenance problems, the availability of ITV's was less than 50%. All 24 of the Infantry crewmen were given gunner tracking training with the Ground TOW, whereas only the 12 squad leaders and gunners were given gunner tracking training with the ITV. The M-70 Jeep-mounted target board was used for tracking with both the Ground TOW and the ITV.

Phase B consisted of 9 days of training and testing which were conducted during the period 16-28 January 1978. Phase B was designed to give refresher training to the crews after they had been away from the ITV for almost 3½ months (6 Oct - 16 Jan). During the design of Phase B, the Infantry School instructors were not aware that 8 of the 24 students would be new to the program. The instruction was given by 6 enlisted men and an officer. The lesson schedule is shown in Table 2. Thirty eight hours of training were scheduled for each crew during 6 days. In addition, 20 hours of pre and post testing were administered during 3 days. Six 4-man crews were again trained with 3 ITV's. Due to maintenance problems the availability of ITV's was about 60%. All 24 crewmen were given Ground TOW tracking training with the Evasive Target Simulator (ETS). The 12 squad leaders and gunners were given ITV tracking training with the M-70 Jeep-mounted target board. All qualification firing during the final two days was accomplished with the M-70 Jeep-mounted target board.

The primary differences between Phase A and Phase B training were as follows:

- 1) Phase B included training on the loading/stowage plan for the Mechanized Infantry version of the ITV.

Table 1

Training Schedule
OT III Infantry Phase A

DATE	TIME	INSTRUCTION
17 Aug. 77	0800-1400	Ground TOW Pre-test
18 Aug. 77	0800-0900	Introduction to XM901 a. XM901 Launcher b. XM901 Weapons Station c. XM901 Stowage/Installation d. AN/TAS-4 (NOTE: 1-hr. rotation w/1-hr. for noon meal)
	1400-1600	M60 MG
19 Aug. 77	0800-1330	a. Gnd TOW Gunnery Technique/ Tgt Engagement b. (1) Fire Command (2) Gnd TOW misfire c. Installation/Dismount Crew Drill (NOTE: 1.5 hr. rotation w/1 hr. for noon meal)
	1330-1630	a. Pre-operation checks b. Crew Drill (NOTE: 1.5 hr. rotation)
22 Aug. 77	0800-1000	a. Combat Misfire XM901 (1 hr.) b. Pre-Operation/PM on XM901 (1 hr.)
	1000-1200	a. Tng Equipment (.5 hr.) b. Crew Drill (1.5 hr.)
	1300-1500	a. Range Card (.5 hr.) b. Evacuation/Destruction Procedures (1 hr.)
	1500-1700	a. Range Card (.5 hr.) b. Tank ID (.5 hr.) c. Leading Procedures (1 hr.) (NOTE: 2 hr. rotation for AM and PM training)

Table 1 (cont.)

DATE	TIME	INSTRUCTION
23 Aug. 77	0800-1300	Pre-Test Make-Up
24 Aug. 77	0800-2300	a. Instructional Firing XM901 b. Instructional Firing M220 c. Instructional Firing M220 W/ANTAS-4
25 Aug. 77	0800-2300	a. Instructional Firing XM901 b. Instructional Firing M220 c. Instructional Firing M220 W/ANTAS-4 and Crew Drill (Firing Sequence)
26 Aug. 77	0800-2300	(Same as 25 Aug. 77)
29 Aug. 77	0800-1700	a. Instructional Firing XM901 b. Qualification M220 c. Instructional Firing M220 W/ANTAS-4 and Crew Drill
	1800-2100	a. Instructional Firing XM901 b. Review for Performance Exam c. Introduction to ITVETS
30 Aug. 77	0800-1900	a. Qualification XM901 b. Performance Exam XM901 c. Requalification SM901/M220 c. Multiple Target Engagements W/Reload
9 Sept. 77	1800-2300	a. Squad/Sec Crew Drill b. Multiple Target Engagement/ Target Acquisition

Table 2

**Training Schedule
OT III Infantry Phase B**

DATE	TIME	ACTIVITY	PERSONNEL
16 Jan Mon	0800-1800	Load Plan Validation	1st Sec
17 Jan Tues	0800-1200	XM901 Pretest	1st Sec
	1300-1700	Gnd TOW Qual	2nd Sec
	1300-1700	Gnd TOW Qual	1st Sec
		XM901 Pretest	2nd Sec
18 Jan Wed	0800-1000	Communication Training	1st Sqd, 2nd Sec
	0900-1200	Gnd TOW Qual	1st Sec
		XM901 Pretest	3rd Sec
	1000-1200	Communications Training	2nd Sqd, 2nd Sec
	1300-1600	XM901 Qual	1st & 2nd Sec
		Gnd TOW Qual	3rd Sec
19 Jan Thur	0800-1000	Communications Training	1st Sec
	1000-1200	XM901 Training	2nd Sec
		Communications Training	3rd Sec
	1300-1500	XM901 Training	1st Sec
		Communications Exam	2nd Sec
		XM901 Qual	3rd Sec
	1500-1700	Communications Exam	1st Sec
		XM901 Training	3rd Sec
20 Jan Fri	0800-1000	XM901 Tracking	1st Sec
		XM901 Training	2nd Sec
		Communications Exam	3rd Sec
	1000-1200	XM901 Training	1st Sec
		Gnd TOW vs ETS	2nd Sec
		XM901 Tracking	3rd Sec
	1300-1700	Maintenance	A11
23 Jan Mon	0800-1000	Gnd TOW vs ETS	1st Sec
		XM901 Tracking	2nd Sec
		XM901 Training	3rd Sec
	1000-1200	XM901 Tracking	1st Sec
		XM901 Training	2nd Sec
		Gnd TOW vs ETS	3rd Sec
	1300-1500	XM901 Training	1st Sec
		Gnd TOW vs ETS	2nd Sec
		XM901 Tracking	3rd Sec
	1500-1700	Gnd TOW vs ETS	1st Sec
		XM901 Tracking	2nd Sec
		XM901 Training	3rd Sec
	1800-2100	XM901 Night Training	1st Sqd, 2nd Sqd 1st Sec, 2nd Sec 3rd Sec

Table 2 (cont.)

DATE	TIME	ACTIVITY	PERSONNEL
24 Jan Tues	0800-1000	XM901 Training	2nd Sec
		Gnd TOW vs ETS	3rd Sec
	1000-1200	XM901 Training	1st Sec
		Gnd TOW vs ETS	2nd Sec
		XM901 Tracking	3rd Sec
	1300-1500	Gnd TOW vs ETS	1st Sec
		XM901 Tracking	2nd Sec
		XM901 Training	3rd Sec
	1500-1700	XM901 Tracking	1st Sec
		XM901 Training	2nd Sec
25 Jan Wed		Gnd TOW vs ETS	3rd Sec
	1800-2100	XM901 Night Training	2nd Sqd, 2nd Sec
	0800-1000	XM901 Testing/Training	1st Sec
		Gnd TOW vs ETS	2nd Sec
		XM901 Tracking	3rd Sec
	1000-1200	Gnd TOW vs ETS	1st Sec
		XM901 Tracking	2nd Sec
		XM901 Testing/Training	3rd Sec
	1300-1500	XM901 Tracking	1st Sec
		XM901 Testing/Training	2nd Sec
26 Jan Thur		Gnd TOW vs ETS	3rd Sec
	1500-1700	XM901 Testing/Training	1st Sec
		Gnd TOW vs ETS	2nd Sec
		XM901 Tracking	3rd Sec
	1800-2100	XM901 Night Training	1st Sqd, 2nd Sec
	0800-1200	Gnd TOW Qual	All
		XM901 Testing	All
		XM901 Testing	All
	1300-1530		
	1800-2100	XM901 Night Training	2nd Sqd, 2nd Sec
27 Jan Fri	0800-1700	Gnd TOW Qual	Sel Ind
		XM901 Qual	All
28 Jan Sat	0800-1200	XM901 Testing	Sel Ind
		XM901 Lead Plan	All
		Nightsight Remote Adjustment Procedure	All

- 2) Phase B included training on vehicular communications for both the Infantry and Cavalry troops. This was determined to be a deficient area after Phase A.
- 3) Phase B included less verbal instruction and less attention to individual students.
- 4) As stated above, Ground TOW tracking training was accomplished with the Evasive Target Simulator.

2.2.2 Cavalry Gunner and Crew Training For OT III

This program was conducted at the Yakima Firing Center by the United States Army Armor School in two phases. The program of instruction for both Phase A and Phase B included basic training in the operation and firing of the ITV without Ground TOW equipment. Subsequent to Phase A, 3 days of informal tactical exercises were conducted.

Phase A consisted of 8 days of training and testing, which were conducted 23-31 August. The instruction was given by 2 enlisted men and an officer. The lesson titles and scheduled times are shown in Table 3. Forty-two hours of training were scheduled during 7 days. In addition, one day at the end of the program was devoted to qualification firing on the ITV.

Two 5-man crews were trained with one ITV which was available about 80% of the time. Tracking training and qualification firing was accomplished with the Jeep-mounted target board.

The Cavalry's program differed from the Infantry's in that each lesson was tested immediately after it was presented and practiced, while the Infantry tested the lesson material during the final two days of the program along with qualification firing. Another difference is that most of the Infantry crew tasks were timed while the Cavalry's were not.

Phase B consisted of 8 days of training and testing which were conducted during the period 18-27 January, 1978. Phase B was designed to give refresher training to the crews after they had been away from the ITV for almost 3½ months. Actually, 5 of the 10 students, including a track commander, were new to the program at the beginning of Phase B. The instruction was given by 2 enlisted men and an officer. The lessons and scheduled times are shown in Table 4. Twenty hours of training were scheduled during 6 days. In addition, one day was required before training for pre-testing, and one day was required at the end of training for final qualification firing. The two 5-man crews were trained with one ITV which was available about 90% of the time. ITV tracking training was accomplished with the Evasive Target Simulator target used with the M70 console, while qualification was conducted using the jeep-mounted target board. Both targets use the M70 console.

The primary differences between Phase A and Phase B training were as follows:

- 1) Phase B included training on vehicular communications.
- 2) Phase B included less verbal instruction and less attention to individual students.
- 3) As stated above, ITV tracking training was accomplished with the Evasive Target Simulator.

2.2.3 Airborne Infantry ITV Familiarization and Tracking Training for DT III

ITV familiarization was conducted at the White Sands Missile Range by the United States Army Infantry School. This occurred during a 5-day period from 8 to 12 August, 1977. The program of instruction included a description of the ITV and associated crew duties, including the dismount and installation of the Ground TOW. The crewmen practiced control of the turret without tracking and went through each of the crew drills one time. Tracking training was conducted under controlled conditions by the U. S. Army Material Systems Analysis Activity (AMSA) as part of the DT III test program.

Thirty-one Airborne Infantry soldiers from Ft. Bragg were selected to participate in the program as player personnel. The DT III program design specified the selection of 7 Expert TOW Gunners, 7 1st Class TOW Gunners, 7 2nd Class TOW Gunners and 10 (11B MOS) with no TOW experience. Qualification firing of the Ground TOW was conducted when the men arrived at White Sands and it was found that the 21 men with TOW experience did not meet the program requirements. They were given firing practice to compensate for this.

2.3 DATA SOURCES AND INSTRUMENTS

Sources of data for training evaluation are:

- a) written tests of knowledge requirements
- b) gunner qualification scores
- c) crew performance tests
- d) post-training tests and operational performance
- e) questionnaires
- f) interviews
- g) monitor comments

The first four listed sources of data are available from the training and test data obtained during the DT III and OT III programs. The test subject questionnaires and interviews have been developed and completed as part of the training evaluation effort presented here. The monitor comments have been provided by the staff personnel responsible for the DT and OT III programs and by the staff responsible for this training evaluation.

The method for developing the questionnaires and the interview format is described in this section of the report.

Table 3

Training Schedule
OT III Cavalry Phase A

DATE	INSTRUCTION
22 August 77	Instructor Preparation; Revision of lessons as required by changes in vehicle design.
23 August 77	Introduction and Safety Characteristics and Nomenclature Operate the Turret MGS Self-Test
24 August 77	Installation and Maintenance of TOW Daysight/Tracker and Night Sight Install M70 Trainer Checkout of M70 Trainer Troubleshoot the XM901 Load and Reload the Launcher
25 August 77	Acquire and Engage Targets with Daysight/Tracker Acquire and Engage Targets with Night Sight Crew Drill
26 August 77	Operate the Grenade Launcher BDA Maintenance
29 August 77	Qualification Firing
1 September 77	NOTE: Firing included 65 shots for day practice and 20 shots for night practice. Also, training included one hour of tracking practice on ITVETS. NOTE: Training on 30 Aug. was cancelled so that USAIS instructors could use SM901 for qualification firing.
1 September 77	Prepare and Occupy Firing Position Prepare a Range Card
2 September 77	Perform Misfire Procedures.

Table 4

Training Schedule
OT III Cavalry Phase B

DATE	
16 Jan Mon	Vehicle Loading/Stowage
17 Jan Tues	Vehicle Loading/Stowage
18 Jan Wed	Characteristics and Nomenclature Operate Turret/Cupola Install/Perform Operator's Maintenance/Put into Operation Day and Nightsights
19 Jan Thur	Issue a Fire Command and Engage Targets Apply Immediate Action: Hangfire and Misfire Communications
20 Jan Fri	Communications Crew Drill
23 Jan Mon	Perform Self Test Install/Remove M-70 Training Equipment Manually Operate Turret/Cupola Prepare a Range Card
24 Jan Tues.	Troubleshoot and Correct Malfunction Load/Reload Weapons System Perform Before, During, and After Operations Maintenance
25 Jan Wed	TOW Instructional Firing
26 Jan Thur	TOW Instructional Firing
27 Jan Fri	TOW Qualification

2.3.1 Training Questionnaire Development

Plans were made to administer two questionnaires on training. The Post-Training Questionnaire was developed for administration to the crews immediately after training, and the Post-Test Training Questionnaire was developed for administration at the end of the test program.

Post-Training Questionnaire

This questionnaire was developed to obtain opinions about all aspects of training prior to participation in the test program. It includes 35 questions which were written to obtain opinions relevant to the key training issues previously identified. Sixteen of the questions require a simple mark on an opinion scale, 6 questions request scaled opinions about each of thirteen subject areas within ITV training, 10 questions request scale opinions plus comments, and 3 questions request comments only. The questions cover the range of generality from opinion about the training program as a whole to opinion about very specific parts of the program. Copies of all training questionnaires are contained in the appendices of the Army Research Institute ITV human factors report (Appendix A).¹

Post-Test Training Questionnaire

This questionnaire was developed to obtain user opinions about the applicability of their training program to the subsequent ITV test requirements and to the operational use of the ITV. It includes questions to determine if the training adequately prepared the men for specific tasks in the test program. The subjects are also requested to estimate if the training prepared them for specific tasks which would be required during combat. Questions are included about the amount of practice required for crew tasks and tracking and about the target procedures preferred for tracking practice. (See Appendix A, ARI ITV Report).

2.3.2 Training Interview Format

Plans were made to interview each subject after each of the two training questionnaires had been administered, i.e., at the end of training and near the end of each of the test programs.

The interview questions were based to a considerable extent upon questions included in the preceding questionnaire. Questions were included in the interviews because they were pertinent to the key training issues, they were suitable for eliciting comments about the

¹Smith, S., Thompson, T. J., and Nicolini, A. Human Factors and Training Evaluation of the Improved TOW Vehicle (ITV) During OT/DT III. Draft Technical Paper, U. S. Army Research Institute For the Behavioral and Social Sciences, May 1978.

training program and/or they were needed to clear up conflicting responses which were obtained from the questionnaires. The leading questions for each topic were defined in advance. It was anticipated that additional questions would be asked during the interviews to encourage each subject to talk so that all of his thoughts on each topic could be noted.

3. RESULTS

Performance data, user observations and monitor comments for the three ITV crew training programs are presented in this section.

Primary attention has been directed to the OT III Infantry program because this program included all aspects of institutional type training for both the ITV and the Ground TOW. The results from this program should be of most value in answering Key Training Issue#1 (Is the ITV training program adequate for new equipment training?), and the results should be of most value in establishing an institutional training program for the ITV. Performance data and observations from the OT III Infantry program provide answers to Key Training Issues #2 and 3, which pertain to the effects of previous TOW experience. Performance data and observations from the DT III Infantry program are of particular value in answering the key training issues which pertain to gunner tracking training.

Performance data and observations from all three of the crew training programs are evaluated to provide an independent assessment of whether or not they met the requirements of the OT III and DT III test programs.

3.1 OT III TRAINING DATA AND OBSERVATIONS - PHASE A

The OT III training program has been divided into Phase A and Phase B. Phase A refers to the initial 10 days of training and testing which were conducted during the period 17-30 August 1977. Interview comments pertaining to subsequent tactical training and/or field practice are included with the analysis of Phase A results. Shortly after the field practice, on 6 October, the test program was discontinued so that alterations could be made in the ITV equipment. Phase B refers to refresher training given in January 1978 when the test program was reactivated. No tactical training was given after Phase B training.

3.1.1 Infantry Training Data

Pre and post training firing data for Phase A are presented in Table 5. Statistical evaluation of differences between pre and post training firing data for the Ground TOW and between the firing data for the Ground TOW and the ITV are presented in Table 6.

Immediately prior to training, 23 crew members were tested with the

Ground TOW on Table VII (Qualification Table). One qualified 1st class, 8 qualified 2nd class, and 14 were unqualified. At the end of training, 24 crew members were tested. Eight qualified 1st class, 15 qualified 2nd class and one was unqualified. The improvement in average scores as a result of training was 17% for Task A, 7% for Task B and 13% for Task C.

At the end of training, 12 squad leaders and gunners were tested with the ITV on Table VII. All of them qualified 1st class; however, they did not all achieve this the first time they were tested. Seven qualified 1st class the first time, 4 had to requalify on one task (3 on Task A and 1 on Task B, and 1 had to requalify on two tasks (Task A and B).

The average post training firing scores with the Ground TOW and the ITV have been compared. During Task A, the scores of the squad leaders and gunners were 5% higher on the ITV than on the Ground TOW. This difference is statistically significant at the .01 level. That is, the difference is sufficiently reliable that it would be expected to occur by chance less than one time in a hundred. During Tasks B and C, the scores were higher on the Ground TOW than on the ITV - 4% higher during Task B and 5% higher during Task C. The 4% difference for Task B is statistically significant to the .1 level, while the 5% difference for Task C is not significant. This is due to the greater variability in scores for Task C. These results conform with crew comments which indicate a preference for the ITV while tracking fast targets. When the scores for all three firing tasks are combined, the small difference between the Ground TOW and the ITV is not statistically significant.

At the end of training, the Infantry School instructors administered tests of 13 different activities, 6 of which were timed. The results are shown in Table 7. There were 14 NO GO's out of 78 tests (6 squads took 13 tests). Nine of the NO GO's were retested after a brief amount of additional training and a GO was achieved in all cases. Five of the NO GO's were given for Load the Launcher. These were not retested because the time standard of 45 sec. was considered to be too short for this task.

The data for qualification firing and crew performance indicate that the time allocated for training was adequate to meet the requirements of the operational test with respect to weapons training on the basic ITV tasks.

Subsequent to the basic ITV training, three days of tactical training were given after which the crews obtained operational experience during a pilot test and during a Battalion FTX. Although tasks were developed for the tactics portion, student performance was not formally evaluated. Unit performance on the following tasks was informally evaluated and approved by the Deputy Test Director for Training.

Table 5

Gunner Qualification Scores
OT III Infantry Phase A

#	INITIAL GROUND MOUNT				POST TNG GROUND MOUNT				POST TNG ITV			
	A	B	C	QUAL	A	B	C	QUAL	A	B	C	QUAL
01	542	867	607	U	595	856	599	2nd	650	812	697	1st
02	674	843	791	1	619	888	779	2nd	678	856	840	1st
03	549	749	632	U	556	779	665	2nd				
04	125	727	404	U	574	787	675	2nd				
05	530	734	492	U	665	865	784	1st	652	854	716	1st
06	560	753	576	2	652	887	768	1st	689	842	739	1st
07	562	759	598	2	614	817	633	2nd				
08	586	771	668	2	659	908	799	1st				
09	626	891	740	2	714	928	838	1st	737	764	672	1st
10	554	783	648	2	690	899	802	1st	662	827	660	1st
11	363	619	519	U	579	914	775	2nd				
12	361	717	560	U	621	920	817	2nd				
13	633	774	707	2	624	838	683	2nd	675	806	777	1st
14	630	843	720	2	656	928	829	1st	670	862	737	1st
15	600	807	768	2	544	836	733	2nd				
16	660	812	545	U	602	799	713	2nd				
17					665	818	700	2nd	693	938	715	1st
18	396	822	729	U	574	781	750	2nd	650	827	695	1st
19	169	659	514	U	591	758	594	2nd				
20	177	718	544	U	623	773	662	2nd				
21	549	883	765	U	663	852	804	1st	671	816	654	1st
22	437	719	630	U	704	812	718	2nd	780	858	762	1st
23	532	642	197	U	365	707	604	UNQ				
24	510	796	712	U	665	847	779	1st				

Table 6

Comparison of Qualification Scores
OT III Infantry Phase A

Ground TOW Training

Task	Initial	Post	* % Change from Initial	** Stat. Signif.
A	557	650	17	.01
B	810	867	7	.05
C	673	760	13	.05
Avg. of A, B & C	680	759	12	.01

Post Training: Ground TOW vs. ITV

Task	Ground TOW	ITV	* % Difference	Stat. Signif.
A	650	683	5	.01
B	867	833	4	.1
C	760	723	5	NS
Avg. of A, B & C	759	746	2	NS

* % Change = $\frac{\text{Initial} - \text{Post}}{\text{Initial}}$

% Difference = $\frac{\text{Diff. Between Ground TOW & ITV}}{\text{Average of Two}}$

** Statistical tests computed by t test for paired observations.

Table 7

Performance Scores - Post Training
OT III Infantry Phase A

TASK	SECTION/SQUAD					
	1/1	1/2	2/1	2/2	3/1	3/2
(NOTE: Tasks 1-4 conducted as SL/DR and GNR/LDR teams, all others are sqd tasks)						
1. Install AN/TAS-4 on day-sight tracker (SL-DR/GNR-LDR)	X/X	X/X	X/X	X/X	X/X	X/X
2. Conduct pre-operation check on AN/TAS-4		X/X/X		X/X	X/X	X/X
3. Boresight align AN/TAS-4 To Daysight Tracker.	X/X	*/X	X/*	X/X	X/X	X/*
4. Place AN/TAS-4 into operation	X/X	X/X	X/X	X/X	X/X	X/X
5. Conduct pre-operation on XM901	X	X	X	X	X	X
6. Troubleshoot XM901	X	X	X	X	X	X
7. Boresight daysight tracker.	X	X	X	X	X	X
8. Issue a fire command (SL)	X	X	X	X	X	X
9. Issue a fire command (GNR)	X	X	X	X	X	X
10. Load the launcher (NO re-test required - unrealistic standard)					X	
11. Perform combat misfire procedures	X	X	X	X	*	X
12. Manually erect the launcher	X	X	*	*	*	*
13. Evacuate the XM901	*	X	X	X	X	X
14. Stow the launcher	X	X	X	X	X	X

NOTE: X denotes a GO; * denotes retest required.

- 1) Select primary, alternate and supplementary positions for engaging enemy targets
- 2) Camouflage the XM901
- 3) Prepare an anti-armor range card
- 4) Move between overwatch positions

At the end of the tactics training, crew performance on operational tasks was considered adequate for the test program. However, there were certain tasks important in combat on which the men did not receive adequate training. These included vehicle identification and map reading. In addition, it would be necessary to establish unit SOP's and provide more training and practice on command and control exercises to prepare the crews for combat.

3.1.2 Infantry Responses to the Post-Training Questionnaire

The post-training questionnaire was administered to all 24 Infantry subjects during the first day after the qualification tests which followed training. The questionnaire is presented in the Annex together with a tabulation of responses after each question according to crew position.

Responses to the questionnaire are summarized below:

The overall quality of the training program was considered very good by a large majority of the subjects (Very Good: 20, Good: 4).

The overall amount of training was considered too short by 14 of the 24 subjects.

The training workload was considered satisfactory by all but one.

The learning objectives and performance requirements were considered clear or very clear by a large majority.

The written material was considered good or very good by 19 of the 24.

The organization of the course was considered good or very good by 18 of the 24.

The use of training aids was considered good or very good by 21 of the 24.

The teaching by the instructors was considered good or very good by all subjects.

Eleven of the 24 men were bothered by distractions during the training program. Comments indicated these were primarily due to heavy traffic around the motor pool area where initial classes were held, the running of track engines, and visiting VIP's.

Twenty of the 24 men thought the size of the student groups was right for training.

Twenty of the 24 subjects indicated they had no problems communicating or working together during crew activities.

Eight men had problems learning to acquire targets and 10 had problems learning to track with the ITV. Comments indicated these were primarily due to insufficient time to practice with the hand controls, uncomfortable location of the hand controls, and problems with these controls, such as drift.

Five felt the transfer of training from Ground TOW tracking to ITV tracking was negative, 8 felt it was positive and 7 indicated no effect.

Seven thought it was harder to learn to track with the ITV than the Ground TOW, 8 thought it was easier and 4 thought the learning difficulty was equal.

Nine out of 12 squad leaders and gunners indicated they did not get enough tracking practice with the ITV. Loaders and drivers received much less tracking practice with the ITV than the squad leaders and gunners.

Twenty-two of 24 indicated they did get enough tracking practice with the Ground TOW.

The following statements of results apply to questions which requested subject opinion about each of 13 subject areas within ITV training. If all 24 indicated an opinion on each of the 13 subject areas, there would be 312 tallies for each question. The 13 subject areas are:

- Locate and Name XM901 Subassemblies
- AN/TAS-4 Night Sight
- Combat Operational Checks
- Operator Maintenance
- Crew Drills
- Evacuation/Destruction Procedures
- Misfire Prodecures
- Range Care/Vehicle Identification
- Training Equipment
- Target Engagement Techniques
- Tracking: Day
- Tracking: Night
- Remedial Training in Ground Mounted TOW

Regarding the difficulty of each of the 13 subject areas (Question 27), the predominant response was Easy. Out of 300 tallies for the various subject areas, 67 indicated Very Easy, 127 - Easy, 72 - Borderline, 30 - Difficult and 4 - Very Difficult. Locate and Name XM901 Sub-

assemblies was judged hardest with 9 tallies for Easy or Very Easy, 11 for Borderline and 3 for Difficult. Target Engagement Techniques and Night Tracking were also judged harder than most subject areas, but still at the easy end of the scale. Remedial Ground TOW was judged easiest with 19 tallies for Easy or Very Easy, 3 for Borderline and 1 for Difficult.

Regarding duration (Question 28), the predominant response for every topic was Right Amount. Out of 291 tallies for the various subject areas, 2 indicated Much Too Long, 21 - Too Long, 214 - Right Amount, 59 - Too Short and 3 - Much Too Short. The one topic which stood out as being judged too short was Night Tracking with 11 tallies for Right Amount, 9 for Too Short, and 2 for Much Too Short. On the other end of the scale, the duration of Remedial Ground TOW was judged Right Amount by 13 and Too Long by 6.

The relative rating of the different subject areas with respect to amount of Hands-on Experience (Question 29), was similar to their relative rating for Duration. Night Tracking again got the most votes for being too short. Hands-on Experience for Night Tracking was judged to be the Right Duration by 11 and Too Short by 12. The difference between the ratings of Duration and Hands-on Experience for the 13 subject areas is that there were more Too Short responses for Hands-on (66) than for Duration(51). Apparently, a number of students feel that an increased duration of the program should be in terms of hands-on experience.

The written material (Question 30), was judged easy to understand by a large majority of the men. Out of 261 tallies for the different subject areas, there were 27 tallies for Very Easy to Understand, 133 for Easy to Understand, 94 for Borderline, 6 for Difficult to Understand and only 1 tally for Very Difficult to Understand. The one subject area which stood out in this response table was Remedial Training for Ground Mounted TOW. No one thought the written material for this subject was Difficult to Understand, 3 thought it was Borderline and all of the rest thought it was Easy or Very Easy to Understand.

A large majority of the crewmen thought teaching by the instructors (Question 31), was Good or Very Good for every one of the 13 subject areas. Out of 286 tallies, there were 139 for Very Good, 124 for Good, 22 for Borderline and only 1 tally for Poor. The weakest subject areas were Locate and Name XM901 Subassemblies and Range Card/Vehicle Identification, each of which received 4 Borderline tallies. The only response of Poor was given for Evacuation/Destruction Procedures, which also received two responses of Borderline.

Feedback information about how each man was doing on the different subject areas (Question 32), was judged to be sufficient by 283 students while 20 thought it was deficient for certain subjects. Range Card/Vehicle Identification got the most negative votes - 4.

In response to a request for recommendations for additions or changes in the training program, there were 18 comments. These comments covered such a wide range of factors that they are difficult to summarize. The most frequent comment included a recommendation for more ITV training and particularly more ITV tracking practice.

3.1.3 Infantry Responses to the Post-Training Interview

The Post-Training Questionnaire served as a format for interviews which took place within two weeks after training. The questions stressed during the interviews were those which had special significance with respect to the objectives of the OT III program.

One significant difference between the questionnaire and the interview is due to the timing. The Post-Training Questionnaire was administered immediately after basic ITV training, and the questions were limited to that phase. The Post-Training Interview commenced after 3 days of tactical training and continued through the pilot test program, during which the troops obtained operational experience with the ITV. The interview included questions about the tactical training, and it was influenced by the operational experience of the troops.

The leading interview questions for each topic are included in this report. Other questions were asked also to encourage each subject to talk. When essentially the same question was asked on both the questionnaire and during the interview, a summary of both sets of responses is included. The summary indicates the general feeling of the subjects about the point questioned. After the summary, specific comments by the subjects are listed. These comments were selected for this report to contribute information. The words of the troops are used when possible. When several commented on the same point, one comment is presented which best represents their collective thoughts. The selection and editing of comments is considered justifiable because the opinion of all of the subjects on each point has been presented as accurately as possible prior to the listing of comments.

Interviews were obtained from 19 of the 24 Infantrymen. These include: 6 squad leaders, 5 gunners, 3 loaders, and 5 drivers.

Orientation to Program

Questionnaire: No question on orientation.

Interview Questions:

- What orientation to the program did you receive at Ft. Lewis?
- What orientation did you receive at Yakima?
- Would more orientation have helped?
- What suggestions do you have for orientation?

Summary of Interview Responses:

14 indicated a need for more orientation.

4 indicated more orientation was not necessary.
1 arrived at the program late and did not comment.

The men were told at Ft. Lewis they would receive some training and would take part in the test of a new TOW vehicle. They were told essentially nothing about the vehicle or the program.

The men received a short orientation to the ITV at Yakima. Very little was said about the training program or the training schedule.

Comments in favor of more orientation indicated it would increase motivation and provide a framework for the material to follow. Some suggested a movie or slide program to show the ITV, its important subassemblies, and its operational employment with demonstration of the duties of the various crew members.

Comments indicated that, for a number of subjects, things did not begin to fall into place until 2 or 3 days had gone by, and that the efficiency of early training would have been improved by better orientation.

Comments indicating no need for more orientation stated this was taken care of during the first few sessions at Yakima.

Specific Comments:

SL: Need better planning and orientation at Ft. Lewis.
Over $\frac{1}{2}$ were not even TOW qualified.
Over $\frac{1}{2}$ not motivated - many getting out soon
Changed list 4 times in 3 days.
First told it would end on Sept. 26, then Nov. 9
Did not know about vehicle or program.
No training schedule; not possible to plan for lessons or for time off.

SL: Ft. Lewis: just told they would receive some training and would test new vehicle.
Yakima: received quick orientation, more would help, although too much would be confusing.
Ground TOW films at Ft. Lewis provided good orientation - helped to relate things in training.

SL: Better orientation indicating what you will have to know would help - things fall into place better.

G: More orientation needed, things came fast to begin with because he didn't know enough about the ITV and especially about the turret.

D: Not told enough about ITV or duration of program at Ft. Lewis.

Better orientation could improve motivation.

- D: More orientation would help.
TOW school at Ft. Lewis had 3 or 4 movies about TOW and tactical effectiveness. One showed the following of a missile during firing. These films were very good.
- D: It was explained at the beginning of the program at Yakima that drivers and leaders would be lucky to get any tracking or firing. This demotivated them.

Organization of Course and Use of Time

Questionnaire, #7: The organization of the course was:

Questionnaire Results:	Very Poor	0
	Poor	0
	Borderline	6
	Good	9
	Very Good	9

Interview Questions:

What do you think of the way the training program was organized?
Was your time used effectively?

Summary of Interview Responses:

Most subjects commented that the basic organization of the course was good. No one recommended a change. Almost everyone commented on the shortage of equipment and equipment problems. Many commented that changes in procedures made it difficult to know what to do. A number commented that the instructors did a good job of compensating for these disruptive effects - particularly by rescheduling activities when equipment was down.

Drivers and leaders complained that they stood around while squad leaders and gunners practiced tracking.

There was general agreement that leaders should be cross-trained as gunners, and many felt that drivers should receive some cross-training on other duties. Some drivers stated that, if cross-training is not to be given to drivers, they should be given training on other things such as vehicle maintenance or driving a 113 in difficult terrain.

It was apparent to the interviewer that motivation of the drivers and leaders could have been improved if it had been stressed that cross-training had to be minimized to conform to the schedule requirements of the OT III program, and that when the ITV becomes operational they will be given more cross-training.

Specific Comments:

- SL: Too much specific information given early in program.
Not enough control over subjects in training.
A subject could goof off early in the course and then have problems later.
Should use more testing during entire course to keep them on the ball.
- SL: There was a shortage of equipment and too many equipment problems, otherwise the organization was good.
SL needs more ITV time because he should know everyman's job.
- SL: There were too many changes in the program that were made on the spot.
Changes should be minimized and discussed after training hours when the students are not present.
- G: Efficiency of the ITV program at Yakima would have been better if more time had been spent on the Ground TOW at Ft. Lewis. He did more Ground TOW tracking here than in Ft. Lewis during an entire year.
- D: They never were told which manuals to bring or what to study in them.
Drivers stood around too much, should have separate vehicle and program for drivers while others practice tracking.
- D: Driver should not be cross-trained because he is in an essential spot.
Driver should get more training on vehicle - maintenance and driving in difficult areas.

Written Material

Questionnaire, #6: The written training material was:

Questionnaire Results:	Very Poor	0
	Poor	2
	Borderline	3
	Good	9
	Very Good	10

Interview Questions:

- What training material did you receive?
How much did you use this material?
Would you recommend this material for the next ITV program or can you suggest changes?

Summary of Interview Responses:

All received the blue ITV book (TC7-999G)
All received the green book on tactics.
Most received TC-2323.
One - 10 manual was assigned to each track
Some - 12 manuals were given out - not sure how many
Squad leaders received a printed pre-op checklist.
Some received a printed summary of crew drill actions.

Use of material: 3 indicated very little
10 indicated some
6 indicated a lot

The interview comments confirmed the questionnaire results which show that the majority thought the written material was good or very good. However, it was the impression of the interviewer that there were more than 3 men who made very little use of the written material. This impression was confirmed by comments by some subjects on use by others.

One reason for the lack of use of the written material by some is that the instructors apparently neither required nor urged the men to use it.

Several comments indicated that lesson plans, which include brief summaries of the important things to be learned, would be of great assistance during the early part of the program. These could aid both preparation and review. They would be of particular help to those who do not refer to the manuals because of reading problems.

This training program had problems because of the numerous changes that were made. Once it is stabilized, print-outs of the pre-op checklist and crew drill actions can provide valuable training and performance aids.

Specific Comments:

- SL: Written material on ITV qualification and preventive maintenance was good (blue book and -10)
Need more on tactics and operational use of ITV - specifically about the ITV.
Pre-op checklist handout good, but had problems - too many changes - O.K. if properly explained and not changed.
- SL: Arrived late at Yakima, relied on written material for makeup.
It was comprehensive and easy to understand.
XM901 (blue book) needs more depth.
- SL: Should condense pre-op checklist and post.
Subjects did not have to refer to written material at all - should be tested during program to motivate them to read.
Simplified list of crew duties would help.

- SL: -10 needs to be better organized, could not find things.
Other written material was good.
- SL: Need something shorter and more user oriented than -10.
Blue book does not have enough in it.
- G: Written material was good except didn't need TC 2323 or book
on tactics (O.K. for SL).
- G: Blue book should be clearer on turret control panel.
Should have better idea of what it is all about before he
gets into turret, e.g., he let go of slew switches at
wrong time.
Green book on tactics was good.
- G: He referred to his notes, not to written material.
Too hard to use written material
Would refer more to material specifically written for class
sessions.
- L: Normally he does not like to use written material
He prefers review points which are not too involved
The written material was O.K., but should be easier to use.
- L: He would use same written material for next program, found
he could go back and read it for points he had missed.
- L: Lesson plans would help for preparation.
Most students don't use the books.
- D: Written material was good, but some outdated.
Written test should be given both before and after the train-
ing program.
- D: Many of the crew drill procedures could be shortened and
made more realistic - they would not be done this way in
combat.
The pre-op checklist included items which should not have to
be checked each time the ITV is to be used. There should
be a shorter checklist which can be used when time is short -
the use of this could be authorized by the Lieutenant.

Use of Training Aids.

Questionnaire, #8: The use of training aids was:

Questionnaire Results:		
Very Poor	0	
Poor	0	
Borderline	8	
Good	9	
Very Good	12	

Interview Questions:

Would you have liked more training aids?
How about a film or slides?
Would more illustrations help?

Summary of Interview Responses:

The most representative comment that came from a number of students was that hands-on experience is best and there should be one ITV per squad.

Those who had suggested the use of a movie or slides for better orientation suggested them again under this topic. However, they frequently added that practice on the ITV is best, and training aids would be of most value early in the program before they start working with the ITV.

One gunner thought initial practice in the turret would be easier to guide and safer if the turret were by itself and not on the 113.

Specific Comments:

SL: Training aids would be of value for initial classes. Might help students avoid mistakes on the equipment.

MANY: Many would like presentations by film or slide at the beginning so they would have a better feel for the system, after that hands-on is best.

Teaching by Instructors

Questionnaire, #9: Teaching by the instructors was:

Questionnaire Results:	Very Poor	0
	Poor	0
	Borderline	0
	Good	7
	Very Good	17

Interview Questions:

What did you think of the teaching by the instructors?
What could they have done to make the course better?

Summary of the Interview Responses:

Response to the first question confirmed the results of the questionnaire. All of the men rated the instructors very high. Many commented that the quality of the instructors compensated for the poor environmental conditions and the problems with the equipment - i.e., lack of sufficient ITV's and maintenance problems.

In response to the second question, the following suggestions were made, some of which were also made in response to the question on the quality of the written material:

- 1) A training schedule should be given out which details the material to be covered during each lesson and which includes reading assignments for student preparation.
- 2) Simple written handouts with illustrations should be given out to clarify points and reinforce the instruction, particularly when memory work is required.
- 3) More control should be exerted over all students. Students who are not practicing tasks on the ITV should be assigned other tasks - possibly read text material, review past lessons and prepare for next lesson.

Communication, Command and Control

Questionnaire, #15: Did you have problems communicating or working together during crew activities?

Questionnaire Results: 4 Yes 20 No

Interview Question: The same question was asked as on the questionnaire and then with respect to specific crew activities and conditions.

Summary of Interview Responses:

When the question was first asked, the usual response was that the CVC's were not working most of the time, but that the squads were able to communicate adequately.

When specific times were mentioned, it was found that they did have problems communicating with the engine running when the CVC's were not working.

There were comments that they should have been trained with the CVC's working in order to communicate properly with them later.

Several commented that a backup system of communication would be of value when the regular communication system is not working. A system of hand and touch signals could be developed and included in the training program.

Concern was expressed about the adequacy of command and control functions by one of the group leaders.

Specific Comments:

PL: When the Section Leader is outside he may be able to talk to G through the intercom if he is not too far away, and he can monitor the radio through the intercom, but he will not be able to talk on the radio. Thus, he will not have direct

control of both vehicles, and he will not be able to talk directly to the Platoon Leader.

PL: When outside the Squad Leader or Section Leader will not be sure which target G is shooting at. More training and practice would help on this problem, but with limited time for communication and with some distance between SL and G, they cannot be sure G is shooting at the target SL wants.

PL: When in closed hatch mode, SL must act on G's description of the target scene. Even with a commander's viewing device, SL will not be able to view enemy action when in defilade. When G is viewing with 13 power and firing, there will be no observation of the entire battle field. The ITV will also be blind during reload when the hatch is closed and when in defilade.

SL; CVC's did not work during most of the training program, get a lot of feedback hum from the ones that do work.

SL: Training should have been carried out with CVC's. Many of the men have had experience with CVC's, but they should have had practice on ITV crew duties with CVC's operating.

SL: No standard signals were developed or taught for backup communication for the ITV, such as hand signals. SL developed a few touch signals with his driver, but this was done on his own. Need army wide SOP's on backup communication for tracked vehicles, and this should be included in the training program.

SL: Must wear CVC's for protection during moving operations and this makes communication even more difficult when they are not working because it is harder to hear direct communication when your ears are covered.

SL: SL worked out a few backup signals with his driver, but found it very difficult to communicate with the Gunner or Loader during moving operations with CVC's not working.

AL: If SL serves as Gunner in order to better observe the battlefield, he will be less able to accomplish his other tasks, particularly during firing, which is a crucial time for SL to be in control.

G: Communication was a problem at times with the engine running and during moving operations when the CVC's were not working. When the CVC's did work, the hydraulic actuator motor caused interference.

G: CVC's are necessary for communication between SL and G during firing.

L&D: Had comments which were similar to some already given by SL and D. L had problem getting his cord tangled during loading.

Target Acquisition

Questionnaire, #16: Were there problems in learning to acquire targets with the XM901? If yes, what were they?

Responses are considered for only squad leaders and gunners because loaders and drivers were not trained on this.

Questionnaire Results: 2 Yes, 10 No

Interview Question: Initial question was same as on the Questionnaire.

Summary of Interview Responses:

When the initial question was asked, the responses conformed with the questionnaire results. However, when specific situations were mentioned, most students indicated they did have problems under certain conditions. The following problem areas were most frequently acknowledged:

Target acquisition in response to Fire Command
Target acquisition at night

Specific Comments:

S: Limitation of field of view is a problem with the ITV. The 3 power field may not be wide enough.

SL: Need more training in acquisition after coming out of defilade. It takes time to get oriented.

G: Had difficulty at first with Fire Command - did not know where 2 o'clock position was, etc. More instruction and practice on communication between the squad leader/observer and the gunner during acquisition would help.

G: Need more training and practice on acquisition at night. It is difficult to know where you are looking at night. Can't differentiate sky from ground.

G: Near objects are easy to acquire at night, but far objects are very difficult to discriminate.

G: The night sight works very well. I am quite pleased with it, but I need more practice on night acquisition.

Target Tracking

Questionnaire, #17: Were there problems in learning to track with the XM901? If yes, what were they?

Responses are considered for only squad leaders and gunners because loaders and drivers were not trained on this.

Questionnaire Results: 6 Yes . 6 No

Interview Question: Same as on the Questionnaire.

Interview Results: 8 Yes 4 No

Summary of Interview Responses:

Eight students stated they encountered problems in getting used to the ITV. The following problems were most frequently mentioned:

- Dead-band in the center of the controller movement
- Hydraulic motors kicking in and out
- Launcher drift when controller was held constant
- Letting go of slew switches at the wrong time
- Control handles were too high
- Not sufficient adjustment in seat height

Four men stated they had no real problems learning to track with the ITV.

Almost all of the test troops indicated that the problems that bothered them at first had less effect on their performance as they received more practice.

Specific Comments:

SL: The ITV seemed loose and it seemed to drift when the control was held constant.

SL: The dead band in the control action, where no response occurred, made it difficult to track an evasive target.

SL: The control handles were too high.

G: The hydraulic motors kicking in and out bothered him, especially at first.

G: Initially had a problem in letting go of the slew switches at the wrong time.

G: No problem learning to track with the ITV. Location and action of controls was good. Could add a couple of pegs in the seat post to make it higher.

G: No problem with either the Ground TOW or ITV in tracking real

targets with mild evasive maneuvers and with some elevation changes. Tracking a slow target was difficult with both the Ground TOW and the ITV, but it was easier with the ITV.

Transfer of Training from Ground TOW to ITV

Questionnaire, #18: Did the things you have learned to do in tracking with the ground mounted TOW make it harder or easier to learn to track with the XM901?

Responses are considered for only squad leaders and gunners because loaders and drivers were not trained on this.

Questionnaire Results:		
Much Harder	0	
Somewhat Harder	3	
No Effect	3	
Somewhat Easier	3	
Much Easier	3	

Interview Question: Initial question same as on the Questionnaire

Summary of Interview Responses:

The interview responses conformed to the questionnaire results. Most of the men thought their Ground TOW training and experience helped them in learning to track with the ITV. Those who thought the Ground TOW experience had negative effects stated that these effects disappeared during the early stages of ITV training.

Specific Comments:

SL: My Ground TOW experience had a negative effect on ITV performance at the beginning, however, this effect disappeared fairly soon.

SL: There are many things that are similar between tracking with the Ground TOW and the ITV. For this reason, my Ground TOW experience helped. However, I initially had some problems with the ITV, which were probably caused by my Ground TOW experience. For example, I exerted too much pressure on the ITV controls.

G: I think all of the practice I have had with the Ground TOW and with the M-70 helped me in learning to track with the ITV.

Transfer of Training from ITV to Ground TOW

Questionnaire, #19: Is it harder or easier to track with the ground mounted TOW after you have been tracking with the XM901?

Responses are considered for only squad leaders and gunners.

Questionnaire Results:	Much Harder	0
	Somewhat Harder	0
	No Effect	8
	Somewhat Easier	3
	Much Easier	1

Interview Question: Same as on the Questionnaire.

Summary of Interview Responses:

The interview responses conformed to the questionnaire results. Several men stated that ITV tracking practice did not have much effect on Ground TOW tracking because the tracking equipment is so different. Those who thought the ITV training helped to improve their Ground TOW tracking usually mentioned some of the similarities in the tracking situation such as the target motion and the M-70 characteristics. Most test subjects indicated they would have no trouble going back and forth between the Ground TOW and the ITV. Several mentioned this would be easy to do if they could continue to practice enough to maintain proficiency on both.

Comparison of Tracking Capability on Ground TOW vs ITV

Questionnaire, #'s 20 through 24: Five questions were included to compare different aspects of Ground TOW and ITV tracking.

Responses are considered for only squad leaders and gunners.

Questionnaire Results:

- #20 Learning to track with the ITV was judged harder by 4, easier by 5 and borderline by 2.
- #21 The ITV was judged better for tracking a slow moving target by 10 vs 2 who favored the Ground TOW.
- #22 Six judged the ITV better and 6 judged the Ground TOW better for tracking a fast moving target.
- #23 Most men (9) thought they did not get enough tracking practice with the ITV.
- #24 Most men (10) thought they did get enough practice with the Ground TOW.

Interview Questions: Same as on the Questionnaire

Summary of Interview Responses:

The interview responses confirmed the questionnaire results for each question.

- #20 No strong feelings were expressed that it was easier to learn to track on one piece of equipment as opposed

to the other. Those who thought the ITV was easier stated that you could rest your head on the eyepiece of the ITV and take it easy after you got on target as opposed to the strain of maintaining a steady track with the Ground TOW.

Those who preferred the Ground TOW usually mentioned the greater ease of target acquisition and greater feeling of direct control over the launch tube.

- #21 Consensus: The ITV is better for tracking a slow target when it is moving steadily in the same direction. Once you get on target, it requires relatively little effort to maintain this condition. Tracking a slow target with the Ground TOW is not as easy because of the difficulty of holding the tube steady. However, several stated that it was more difficult to track an evasive target with the ITV because it was difficult to achieve a smooth transition across the center null-point in the controller action.
- #22 Most men seemed to feel they could track a fast-moving target better with the Ground TOW. The most frequently expressed comment was that the gunners and squad leaders had had more experience with the Ground TOW and could therefore track better with it. Several thought they might be able to track a fast moving target better with the ITV if they were given more practice.
- #23 The interview confirmed the questionnaire in that 9 said they did not get enough practice with the ITV while 3 said they did get enough. Several men stated that they probably got enough practice during the training program provided they subsequently received regular practice at their home base. They stated it would be better to spread the practice out so that it would not get so boring and so that they could maintain their proficiency.
- #24 The interview confirmed the questionnaire in that almost all of the test subjects stated they received enough practice with the Ground TOW. Here again, several said they should get regular practice at their home base to maintain proficiency. One stated that he got more tracking practice at Yakima than during the previous year at their home base.

Range Card Makeup and Range Determination

Questionnaire, #25: Were there problems in learning to determine range during the XM901 program?

Questionnaire Results:

0 Yes

22 No

Interview Question: Were there problems in learning to make up a range card and in learning to determine range during the training program?

Summary of Interview Responses:

The initial question was followed by questions about whether the men could perform the tasks included in the training session under specific conditions. After these questions, the student was asked if the training session was adequate for the two primary tasks: range card makeup and range determination. The responses can be categorized as follows:

Range Card:	Responses
Adequate for those without previous experience	2
Adequate for those with previous experience	11
Not adequate	5

Specific Comments:

SL: He has had a basic course on range cards. Each time he gets a review, the symbols and methods change.
Better not to have options - need SOP's.
Not enough on range determination in the ITV program, particularly at night. He has had some training on range determination, but not nearly enough.
Both range card makeup and range determination should be practiced in different types of terrain.

SL: The instructional environment was poor.
The material on range cards, together with instruction on the use of maps, should be presented first in the classroom before going to the field. Each man should have a desk and working material to practice with.

SL: The range card session was too short and very little was said about range determination. Should also get more on tank identification. Need continuous practice on range determination and on tank identification.

G: New material on target reference points should be presented to units back home and to higher officers.

G: The training session was adequate because of his previous experience. For inexperienced students, the training session should be much longer with much more time for practice.

G: Need more on range cards and range determination in different terrains. The terrain at Yakima was too uniform.

G: The training session was adequate, but need more practice on the use of maps and on range determination with and without maps.

D: The total class period was about 30 min., with about 10 min. on range determination. This is not long enough.

Problems with Night Operations

Questionnaire, #26: What problems did you have learning night operations that have not been mentioned in answers to previous questions?

Questionnaire Results: All men wrote "none" except one gunner who wrote: "Just new acquaintance with the AN/TAS-4."

The lack of response is probably due to the predisposition to avoid written responses and to the fact that this was the last question on the questionnaire.

Interview Question: The initial question was the same as on the Questionnaire. Then questions were asked about the night operation of specific duties each student crewman was responsible for.

Summary of Interview Responses:

Night problem areas included:

Targets were difficult to acquire because of disorientation.

Distant targets were difficult to discriminate.

The lighted target on the Jeep made it difficult to see the small stadia lines in the night sight.

Lack of azimuth and elevation readouts contributed to the orientation problems.

Need for better placement of lights in the crew compartment.

Difficult replacement of night sight during remount drill.

Need to replace nitrogen and batteries frequently.

Need to run up engine to keep battery charged.

Specific Comments:

SL: Mount and dismount operations can be performed in less than 2½ min. during both day and night operations. The biggest problem, both day and night, is the mounting of the night sight.

SL: Need both an azimuth and elevation readout. Otherwise it is difficult to keep track of where the launcher is pointed at night.

SL: The target cross on the Jeep was too large and too hazy which made it hard to see the small stadia lines in the night sight.

G: It is difficult to acquire targets at night. I could not tell where I was looking - could not even tell the difference between sky and ground.

- G: When using the night sight at night, it is very difficult to be sure you are looking at the right target if it is far away. If there is only one thing out there that looks like the target, then you may be able to pick it out.
- G: The night sight was good, but need more practice with it.
- G: Range estimates are difficult to make at night. It is also difficult to use the range card at night.
- L: Loading was difficult in the dark. Hard to get the missile onto the launcher guide rails. Phosphorous paint would help. Also easy to get mashed fingers while loading.
- L: Easy to push the latches, for locking the missile in place, past the detent position. Need some kind of a stop mechanism to prevent this.
- D: It is almost impossible to replace the night sight at night unless you're very lucky. Should have an extra night sight in case of damage.
- D: The nitrogen bottles were going down fast, so were the batteries.
- D: The driver had to stay in his station to run up the engine to keep the battery up.

Adequacy of the Different Parts of the ITV Training Program

Questionnaire, #'s 27 thru 32. Student written responses to these questions are discussed in Section 3.1.2 Infantry Responses to the Post-Training Questionnaire.

Interview Questions: A list of the 13 subject areas in the ITV training program was shown to each subject. He was then asked to consider each subject in order and to state if that subject was covered adequately, to indicate whether more or less time should have been devoted to it and to describe any problems that he had with that subject.

Each subject area is listed below together with representative student comments about it.

The number of comments indicating a need for more training conformed in most cases with the written answers to questions 28 and 29, which pertained to duration and amount of hands-on experience, in the Post-Training Questionnaire. Two notable exceptions were: Evacuation and Range Card/Vehicle Identification. There were approximately 3 times more responses in the interview for these two subjects.

Locate and Name XM901 Subassemblies

This was the hardest class. Need more time for it and good handouts.

This was taught to a large group. The group should be smaller and each member should have a chance to examine the different equipment items.

A good hand-out on this emphasizing the important things to know would help a lot.

Need more on the entire vehicle and its capability.

AN/TAS-4 Night Sight

The mechanics for installation and for boresighting of the night sight must be improved.

Need more practice in working with the night sight.

Combat Operational Checks

More efficient procedures should be worked out for doing the operational checks. They took too much time because they were not always done the same way. Setting a time limit would force each squad to improve its procedures, but the men might begin to cut corners and not do things properly.

The procedures were changed too many times.

The initial instruction on operational checks was hard to follow because the men were not sufficiently familiar with the equipment. After that, the men were on their own and had to work out their own procedures.

Operator Maintenance

Should be given more training on operator maintenance, especially for the launcher assembly. The class was probably O.K. for an experienced group. Very little was given on the -10, possible because the men had had previous experience with it.

Need more training on maintenance of machine gun.

New men would need training on track maintenance.

Crew Drills

Should be given a hand-out on crew drill commands and procedures. Avoid changes after the procedures have been established.

Need more training and practice on certain crew drill activities at night. Loading was definitely a problem.

Need more training and practice on Fire Command.

Evacuation/Destruction Procedures

Evacuation procedures need improvement.

Evacuation was done only once under one condition. It should be taught for a number of different emergencies and for a number of different states of the vehicle (position of launcher and turret, etc.). It should then be practiced a number of times.

Evacuation should be practiced with all required items stowed aboard the vehicle and with the men wearing full field gear.

Need faster techniques for destruction and more training.

Misfire Procedures

His team had trouble coordinating the misfire procedures. They should have been explained more completely and then demonstrated.

Printed hand-out on this would help.

Procedures should be learned better for retention.

When vehicle has to be moved, the squad leader should be more visible to the driver for safety.

Driver does not always know which way to move vehicle during misfire when the CVC's are not working and the engine is running.

Range Card/Vehicle Identification

Vehicle identification was hardly covered. This is very important.

More training should be given on it and it should be practiced regularly in the home units. A good method of rapidly presenting models or projected images of the vehicles must be used. Vehicle identification is taught at the home post now, but it is not given enough attention.

Range determination should also receive more training and then regular practice at the home post.

Training Equipment

Got a feel for the training equipment after working with it for several days. The initial instruction on it should have been more complete.

Target Acquisition/Engagement

Target acquisition is more difficult in the ITV because of the restricted field of view.

Standard operating procedures for communicating target location should be established and practiced under different conditions.

Tracking: Day

Need more tracking practice.

Tracking: Night

Need more tracking practice under both day and night conditions, but especially at night.

Need azimuth and elevation readouts particularly for night tracking because orientation is a problem.

Need a better target cross on the Jeep for night tracking.

The one they have now is too big and bright.

Remedial Training in Ground Mounted TOW

Some have been in the organization only 4 weeks. They needed this, but there was too much for the others with previous TOW experience.

Learned new things about how to track with the Ground TOW that

helped a lot.

Tactics Training

Two days of training on tactics were given after the post-training qualification firing. The first day of tactics consisted of a 3-hr. lecture and a 3-hr. exercise with a terrain model. The second day consisted of a brief lecture and exercise on camouflage and several hours of field maneuvers.

The Post-Training Questionnaire did not include questions on the tactics training; however, the Post-Training Interview did include questions on this training. The comments are summarized below:

- 1) The lecture was well presented, but a little too fast and without sufficient interaction from the students.
- 2) The model was a good approach, but it should have been used with smaller groups. With the entire class broken into two opposing sides (12 on each side), the only ones making decisions were the Platoon Leader and the Squad Leaders. The others did not get as much out of it and some did not follow what was going on.
- 3) The instructor should have gone through an exercise with the model first before turning the group loose on it.
- 4) More of a debriefing should have been given after the exercise with the model.
- 5) A better system for camouflaging the ITV has to be developed. There is a need for methods of attaching the camouflage to the vehicle.
- 6) The initial briefing on the maneuvers was not adequate. Many of the men did not know what was going on.
- 7) The men need more training on map reading and navigation. Most of the men don't know how to do it. This includes some of the squad leaders.
- 8) Most of the men feel the need for more training and field exercise on tactics and maneuvers.
- 9) There is a need for more SOP's in the operational use of the ITV.
- 10) The maneuvers demonstrated some of the limitations of the ITV.
 - It can't track at an angle
 - It has power limitations for getting in and out of defilade
 - Maximum speed is much less than a tank's
 - Not enough space for all equipment
 - Need a better communication system between ITV's

3.1.4 Cavalry Training Data

Firing qualification and task performance data for the Cavalry test subjects during Phase A are presented in Table 8.

Firing qualification occurred at the end of training. All of the Cavalrymen qualified 2nd class. Two achieved 1st class on Task A, 2 different ones achieved 1st class on Task B, 3 achieved 1st class on Task C and 3 achieved Expert on Task C.

The Cavalry administered tests to 15 individual and crew tasks during the course of the training program. When the men received a NO GO after a block of instruction, they were given a brief amount of additional training and retested. At the end of training every one had achieved a GO on every test.

3.1.5 Cavalry Responses to the Post-Training Questionnaire

The Post-Training Questionnaire was administered to 9 of the 10 Cavalry test subjects during the first day after the qualification tests which followed training.

Responses to the questionnaire are summarized below.

The overall quality of the training program was considered good or very good by 8 of the 9 men.

The overall amount of training was considered too short by 4 of the 9.

The workload was considered satisfactory by all of the men.

The learning objectives were considered clear or very clear by all of the test subjects.

The student performance requirements were considered clear or very clear by all.

The written material was considered good by 5, on the borderline by 2 and poor by 2.

The organization of the course was considered good or very good by 8 of the 9.

The use of training aids was considered good by 3, borderline by 5 and poor by 1.

Teaching by the instructors was considered good or very good by all.

TABLE 8
Qualification and Performance Results - Post Training
OF III Cavalry Phase A

RANK	DUTY POSITION	MGS SELF-TEST (40 MIN)	INSTALL/Maintain DAY/NIGHT SIGHTS (3 HR)	INSTALL M70 TRAINER (30 MIN)	TROUBLESHOOTING (4 HR)	ENGAGE TARGETS WITH NIGHT SIGHT (4HR)	M70 CHECKOUT (30 MIN)	RANGE CARD (2 HR)	PREPARE AND OCCUPY A FIRING POSITION (2 HR)	IMMEDIATE ACTION (2 HR)	OPERATE THE TURKET (5 HR)	ACQUIRE/ENGAGE/SELECT TARGETS WITH THE TOW (3 HR)	CREW DRILL (4.5 HR)	OPERATE THE GRENADE LAUNCHER (1.5 HR)	LOADING (3 HR)	TOTAL TIME - 42 HOURS	INSTRUCATIONAL FIRING DAY/SIGHT (# SHOTS)	INSTRUCATIONAL FIRING NIGHT SIGHT (# SHOTS)	QUALIFICATION FIRING DAY/SIGHT (# SHOTS)	SCORE-TASK A	SCORE-TASK B	SCORE-TASK C
1	SGT TC	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	65	20	30	570	757	784
2	SP/4 LDR	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	65	20	30	604	786	813
3	PFC OBS	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	65	20	30	583	807	685
4	PFC DVR	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	65	20	30	612	786	671
5	SP/4 OBS	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	65	20	30	594	761	794
6	SGT TC	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	65	20	30	655	813	694
7	SP/4 DVR	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	65	20	30	581	810	622
8	SP/4 LDR	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	65	20	30	651	790	641
9	SP/4 OBS	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	65	20	30	600	833	639
10	PFC OBS	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	65	20	30	594	798	587

¹ NO. 9 DEPARTURE TRAINING SITE ONE DAY EARLY AND MISSED TRAINING

Five of the 9 men were bothered by distractions during the training program. Comments indicated these were due to noise and activities in the shop area where initial classes were conducted. Interruptions by mechanics and visiting VIP's were also included in the written comments.

Two thought the size of the class group was too large when both crews were training on the same ITV.

Eight of the 9 indicated they had no problems communicating or working together during crew activities.

Five test subjects indicated they had problems learning to track with the ITV. Equipment problems and the need for more practice were each mentioned twice in the comments.

Six had previous experience as tank gunners and 3 of these indicated this helped in learning to track with the ITV.

Two indicated they did not get enough tracking practice on the ITV.

Questionnaire responses about the specific lessons indicated no problem areas in the program. There were a number of responses indicated that all parts of the program were too short, particularly the hands-on practice.

General comments written in response to a request for recommendations included the following:

- a) Should have had one ITV per squad
- b) Maintenance problems disrupted training
- c) Need more practice tracking real tanks
- d) The ITV is not suitable for the Cavalry.

3.1.6 Cavalry Responses to the Post-Training Interview

The method of administration of the Post-Training Interview to the Cavalry and the timing was the same as for the Infantry, as described in Section 3.1.3.

Responses of the Infantry crewmen to the Interview have been presented in some detail because the Infantry program is considered the primary basis for the establishment of institutional training for the ITV. Responses of the Cavalry crewmen are presented here only if they contribute information unique to the Cavalry or information not already presented in Section 3.1.3.

Specific Comments:

There is a need for material written specifically for the Cavalry. For example, the blue ITV book (TC7-999G) only discusses Infantry applications of the ITV.

The men should be given written material which should include the training schedule and a summary of the material for each lesson. The instructors had lesson material, but this was not accessible to the men.

The CVC's did not work and there were communication problems during the crew activities.

There should have been more training on troubleshooting.

There was no training on evacuation - this is important.

There is a need for better techniques for turret training. It is hard to follow the instructor when the gunner is in the turret.

Tracking practice should be spread out over a longer period. The Cavalry received tracking practice after most of the other tasks in the training program had been achieved.

There is a need for more training on command and control and tactics. There is particularly a need for the practice and testing of these functions.

During the final days, in which field maneuvers were practiced, there was no coordination between moving vehicles.

There is a need for more storage space. The ITV is too cramped for 5 men.

During the final days of training and during the field maneuvers, all required equipment, including personal gear, should have been stowed in or on the ITV. This requires practice and we might discover some problems.

The Cavalry ITV crew should consist of 4 men. The 5th man is not used effectively, he is in the way during missile loading, and he takes up valuable storage space.

The ITV needs a more powerful engine and it is too sensitive for scout maneuvers. The scouts need a vehicle that will go anywhere with high speed.

The ITV should not be a scout vehicle. The ITV is most effective when it is somewhat behind the front line, whereas a scout vehicle is supposed to be in front of the front line.

3.1.7 Comparison of Basic Training and the Results of this Training for Infantry and Cavalry Programs

A comparison is presented between the Infantry and Cavalry programs because it is relevant to a number of key training issues.

Differences between the Infantry and Cavalry troops participating in OT III include the fact that those in the Infantry have acquired TOW experience while those in the Cavalry have not. Thus, a comparison between Infantry and Cavalry training will provide information directly relevant to the second key training issue previously listed: "What is the length of time required to train an ITV crew with and without TOW experience?" Information relevant to the effects of transfer of training between the Ground TOW and the ITV (Training Issue #3) will also be highlighted by the comparison of Infantry and Cavalry training, because transfer will have occurred during Infantry training and it will not have occurred during Cavalry training. In addition, information about the adequacy of ITV training (Training Issue #1) will be obtained by an examination of the two training programs.

The training which occurred prior to the qualification tests was oriented primarily toward achieving proficiency in crew drill activities and toward achieving qualification on the Table VII TOW firing scorecard. A comparison of the training schedules for the Infantry and Cavalry (Tables 1 and 3) will show that the two programs were quite similar with respect to the topics covered during this basic ITV training.

Most of the training on tactics and on the operational use of the ITV occurred after the qualification tests for both the Infantry and Cavalry programs. This training is quite different for the two applications and is not considered in this comparison of the two programs.

Differences in Pre-Qualification Training

All of the Infantrymen had several months of previous experience with the ground mounted TOW. During the ITV training program all Infantrymen were given remedial training and firing practice with the Ground TOW.

None of the Cavalrymen had previous Ground TOW experience, and they received no training on it except for a brief period of familiarization.

The Infantry squad leaders and gunners received tracking practice in the ITV and were evaluated on Table VII of the TOW firing qualification test. Other than this, there was very little cross-training of ITV crew duties. The loaders and drivers did not practice tracking in the ITV and they were not tested on it.

The Cavalry received a considerable amount of cross-training on ITV duties in addition to their own. All of the Cavalrymen received tracking practice in the ITV and all were tested on Table VII of the TOW firing qualification test.

Comparison of Scheduled Training Time

The Infantry scheduled 60 hours of training during 7 days between 18 through 26 of August. Remedial training and firing practice with the ground mounted TOW consumed 24 of the 60 hours, which leaves 36 hours of training on the ITV. Qualification tests occurred on 29 and 30 of August. Training on tactics and on the operational use of the ITV was given after the tests; however, this is not considered in this comparison.

The Cavalry scheduled 42 hours of training, which occurred during 6 days between 23 and 31 of August. Approximately 4 hours of this training was devoted to familiarization with the ground mounted TOW, leaving 38 hours of training on the ITV.

The schedules of both the Infantry and Cavalry were disrupted because of problems associated with the equipment. Although the order of training events was altered somewhat, the estimate of total training time is considered reasonably accurate. It should be emphasized, however, that training time does not indicate the amount of hands-on experience for each student. The instructors utilized the equipment as effectively as possible, but each student did not have access to equipment during the entire training periods.

Comparison of Firing Practice and Qualification Data

It is difficult to ascertain how much tracking practice each man got because of limitations and variations in the availability of the equipment. The Infantry allotted 12 hours of ITV tracking practice time for 12 men (squad leader and gunner from each of six squads) to provide an average of 1 hour of practice/man. The Cavalry allotted 9 hours of ITV tracking practice time for 10 men to provide an average of 0.9 hours of practice/man.

As presented previously in Sections 3.1.1 and 3.1.4, all of the Infantry squad leaders and gunners qualified first class (5 had to requalify to achieve this) and all of the Cavalry qualified 2nd class on TOW Firing Table VII. The qualification data demonstrate that the time allocated for tracking practice is adequate to meet the performance standards. However, there was insufficient time for practice to insure retention of firing skills and to insure adequate performance under stress. The need for more tracking practice was supported by questionnaire results in which the majority of men expressed such a need.

With respect to the needs of the OT III test, the amount of tracking practice appears to be sufficient to produce representative test personnel. With respect to the requirements of an institutional program, the present duration of both the Infantry and Cavalry programs should be sufficient to provide the necessary firing skills if one ITV is provided for each squad and if there is no down time for maintenance.

The superior tracking performance of the Infantry squad leaders and gunners can probably be accounted for by two factors: 1) selection and 2) related tracking experience. Squad leaders and gunners of a TOW unit are selected and/or promoted on the basis of their general capability and their TOW tracking capability. Both of these capabilities should contribute to their ability to learn and perform ITV tracking.. Some of the Cavalrymen had previous experience as a tank gunner; however, this was not recent and it is less related to TOW tracking.

The Infantry squad leaders and gunners not only had TOW tracking experience prior to this training program, but they also accumulated almost as much tracking time on the ground mounted TOW during the program as with the ITV.

Based on experience with other psycho-motor skills, it would be predicted that the many similarities between tracking with the ground mounted TOW and with the ITV would contribute to a continuing positive transfer between the two, while the negative effects would be reduced during the first training sessions. Comments during the interview on training support this position. Thus, it seems reasonable to assume that the superior tracking performance of the Infantry can be accounted for, at least to some extent, by positive transfer.

Most of the Cavalrymen should be able to qualify 1st class after one or two more days of tracking practice with one ITV per squad. Since no selection has occurred, a few could be expected to have difficulty qualifying 1st class due to limitations in such basic factors as psycho-motor coordination or vision.

Comparison of Crew Performance Test Results

Both the Infantry and the Cavalry achieved their specified performance objectives during the time allotted for training. Comments indicate the objectives could have been attained in less time if an operational ITV had been assigned to each squad.

Although all of the men passed the performance tests, several in both the Infantry and Cavalry groups indicated a need for additional training and/or practice on certain tasks. Both groups frequently recommended additional training for range determination and night acquisition. Several Infantrymen also recommended that Evacuation procedures be specified and trained for a variety of conditions, including orientation of the turret and launcher to block exit from one or more of the hatches. Cavalry troops apparently were not trained on Evacuation.

The present duration of each of the two training programs appears to be sufficient to provide the necessary practice on individual and crew duties promote retention and reliable performance under stress if one ITV is to be provided for each squad and if there is no down time for maintenance. This duration applies to the basic institutional type training. Training on the operational use of the ITV would be a valuable addition to the basic training to immediately add meaning to the basic instruction and promote greater retention. Comments indicate there may be a long interval between institutional training and operational training at the home unit.

3.2 OT III TRAINING DATA AND OBSERVATIONS - PHASE B

The Infantry and Cavalry training programs in Phase B were designed to give refresher training to the crews after they had been away from the ITV for 3½ months. The instructors in the Infantry School and the Armor School, who designed the Phase B training, were not aware of the large number of new personnel to the program. Eight of the 24 Infantrymen and 5 of the 10 Cavalrymen had not been exposed to the ITV prior to Phase B. Because of the short notice the training programs were not redesigned to accommodate the special needs of the new subjects.

The schedule for Infantry Phase B training is presented in Table 2, and the schedule for the Cavalry Phase B training is presented in Table 4. The primary difference between Phase A and Phase B training (which may not be evident from an examination of the schedules) is that less time was allocated during Phase B for verbal explanation of the tasks and for assistance to individuals.

3.2.1 Evaluation of Test Subjects' Bias Toward the ITV and the OT III Test Program

There was concern at the beginning of Phase B that the test personnel might have developed a negative bias toward the ITV and the training and test programs. Two factors, in particular, could have contributed to the development of a negative bias:

- 1) A large number of mechanical failures occurred in the ITV during Phase A. The failures could have brought about a loss of confidence in the ITV, and they did reduce the efficiency of Phase A training because of the consequent shortage of equipment.
- 2) The troops were recalled to the program in November and then immediately sent back to their home post because the ITV's required additional upgrading. This could have contributed further to a loss of confidence in the ITV, and it did produce ill feeling because elaborate plans had been made by the men for their move to Yakima.

A questionnaire was administered at the beginning of Phase B to all of the subjects who had participated in Phase A. This was designed to evaluate subject opinion about the ITV on a number of characteristics, and to evaluate feelings about participating in the test program. The questionnaire and response averages for the Infantry and Cavalry are presented in the Appendix A, ARI ITV Report.

3.2.1.1 Ratings of the ITV and the Test Program by Infantry Test Subjects

The predominant response is given here for each of the ITV characteristics. (Response choices were: Very Good, Good, Fair, Poor, Very Poor)

- | | |
|--------------------|-----------------------|
| 1. Ruggedness | Between fair and poor |
| 2. Reliability | Between fair and poor |
| 3. Vulnerability | Between fair and poor |
| 4. Crew protection | Good |

5. Safety	Between fair and good
6. Storage capacity	Poor
7. Crew working space	Average of poor, but spread out
8. Ability to detect targets	Between fair and good
9. Ability to identify targets	Between fair and good
10. Ability to track targets	Good
11. Ability to hit targets	Good
12. Ability to use secondary armament	Fair
13. Ability to set up quickly	Good
14. Ability to depart quickly	Good
15. Ability to reload quickly	Between fair and good
16. Overall design of ITV	Fair
17. Overall rating of ITV	Fair
18. Overall rating of Ground TOW	Between fair and good

Predominant responses with respect to feelings about the ITV and test program are as follows:

19. Overall opinion of ITV	Like it
20. Importance of OT III	Between important and very important
21. Being part of OT III	Between like and very much like being part of program

The Infantry responses to the questionnaire were encouraging. They demonstrated differential sensitivity to the different questions. For example, characteristics such as ruggedness, reliability and storage capacity were rated at the poor end of the scale, while crew protection and the ability to respond quickly and to track were rated at the good end of the scale. Most encouraging were the indicated feelings of the test subjects toward the ITV and the test program. On all three questions designed to measure feelings, the responses were at the very favorable end of the scale.

3.2.1.2 Ratings of the ITV and the Test Program by Cavalry Test Subjects

Only 4 of the 5 Cavalrymen who attended Phase A completed the questionnaire. Because of the small number it is not possible to arrive at meaningful conclusions. Most of the ratings of ITV characteristics were in the good and fair categories, although many responses were spread across the entire scale. No differential sensitivity is exhibited by responses indicating feelings about the ITV and the test program (#'s 19, 20, and 21) were not clustered at the favorable end of the scale, as with the Infantry, but were more spread out.

3.2.2 Infantry Training Data

Prior to Phase B training, a pre test of crew performance and firing qualification on the Ground TOW and ITV was conducted on 17-18 January 1978. This test was given only to those who had completed Phase A training.

3.2.2.1 Pre-training Data

Pre-training firing scores are presented in Table 9. The 24 Infantry crewmen were tested on Table VII with the Ground TOW. Two qualified 1st class, 10 qualified 2nd class and 12 did not qualify. Ten squad leaders and gunners were tested with the ITV. None of them qualified.

Results of the crew performance tests are presented in Table 10. Performance of the 6 crews was tested on 15 ITV tasks which resulted in 90 test scores. There were 21 GO's and 69 NO GO's.

These data support the often expressed comment by the men that practice of crew tasks and firing should occur at regular periods at the home base, and that this practice should be scheduled more frequently for the ITV than in the past for the Ground TOW.

One factor which contributed to the low qualification scores, was the fact that the target board was mounted on a 113, which moved along terrain rougher than the road traversed by the Jeep, which carried the target board during qualification firing at the end of Phase A training.

3.2.2.2 Post Training Data

Post training firing scores are presented in Table 11. During Ground TOW qualification firing, 11 qualified 1st class, 7 qualified 2nd class and 2 were unqualified. Four men were missing. During ITV qualification firing with squad leaders and gunners, 10 qualified 1st class and 2 qualified 2nd class.

Firing qualification was better at the end of Phase B than at the end of Phase A. At the end of Phase A, the numbers qualifying 1st, 2nd, and unqualified on the Ground TOW were 8, 15, and 1, compared with 11, 7, and 2 plus 4 experts at the end of Phase B. At the end of Phase A, the numbers qualifying 1st and 2nd class upon first try with the ITV were 7 and 5, compared with 10 and 2 at then end of Phase B. At the end of Phase A, the men were retested until they all achieved 1st class on the ITV. This was not done at the end of Phase B.

At the end of training, performance of the 6 crews was tested on the 15 tasks. The results are presented in Table 12. This time, there were 67 GO's and 23 NO GO's. All of the NO GO's were retested resulting in a GO in each case.

Task performance at the end of Phase B was not as good as at the end of Phase A. When first tested, 15% of the tasks were NO GO at the end of Phase A, while 26% were NO GO at the end of Phase B. As previously stated all of these were changed to GO upon retest.

3.2.3 Infantry Questionnaire Data and Observations on Phase B Training and Comparison with Similar Data on Phase A

A summary of student observations about the Phase B training program is presented here. Specific comments are included only if they add information to that already presented on Phase A training. A report which includes a comparison of questionnaire responses obtained after the Phase A and Phase B training programs, together with a summary of interview comments after each question, was provided to both the OTEA Field Test Manager and to the Deputy Test Director for Training.

TABLE 9

Qualification Scores - Pre Training
OT III Infantry Phase B

*Denotes New Crew member

	Position	Date	GND TOW				Date	XM901			
			A	B	C	Q		A	B	C	Q
1	SL	17-18 Jan	581	833	747	2	18 Jan	726	524	275	U
2	*G	17-18 Jan	233	760	552	U	18 Jan	97	143	95	U
3	L	17-18 Jan	221	896	725	U					
4	D	17-18 Jan	13	807	758	U					
5	SL	17-18 Jan	582	869	754	2	Absent				
6	G	17-18 Jan	594	843	637	2	18 Jan	288	520	402	U
7	L	17 Jan	535	813	819	U					
8	*D	17 Jan	262	771	727	U					
9	SL	17 Jan	586	813	848	2	18 Jan	255	574	571	U
10	G	17 Jan	575	882	900	2	18 Jan	201	415	162	U
11	*L	17 Jan	588	849	786	2					
12	D	17 Jan	741	799	651	1					
13	SL	17 Jan	735	957	903	1	18 Jan	205	499	565	U
14	G	17 Jan	630	880	914	2	18 Jan	490	633	645	U
15	*L	17 Jan	195	566	314	U					
16	D	17 Jan	620	914	771	2					
17	*SL	18 Jan	523	709	684	U	18 Jan	129	196	403	U
18	G	18 Jan	711	781	847	2	18 Jan	396	644	578	U
19	L	18 Jan	355	806	774	U					
20	*D	18 Jan	570	784	735	2					
21	SL	18 Jan	511	672	584	U	18 Jan	459	705	552	U
22	*G	18 Jan	410	706	459	U	Absent				
23	L	18 Jan	217	702	534	U					
24	D	18 Jan	521	772	543	U					

TABLE 10
Performance Scores - Pre Training
OT III Infantry Phase B

All tasks were performed as squads. New students were integrated as crew members.

TASK	TESTED	FAILED
Conduct Preoperational checks on the AN/TAS -4	6	3
Install/stow M220A1 Components on an XM901	6	5
Conduct Preoperational Checks on the XM901 Primary Weapons System	6	6
Identify Faults/Report Actions To Be Taken (Troubleshoot) on the XM901 Primary Weapons System	6	6
Boresight a Day-Sight/Tracker	6	6
Boresight/Align the AN/TAS-4 to A Daysight/Tracker	6	6
Place the AN/TAS-4 into Operation	6	5
Manually Erect the XM901 Launcher	6	6
Manually Acquire and Engage a Target	6	6
Issue a Fire Command to an XM901 Gunner	6	6
Reload the Dual Launcher	6	5
Perform Combat(Simulated) Misfire Procedures	6	6
Stow the XM901 Launcher	6	2
Evacuate the XM901	6	2
Dismount/Assemble the M220A1	6	0
Qualify With the XM901	10	10

TABLE 11

Qualification Scores - Post Training
OT III Infantry Phase B

*Denotes New Crew Members

	Position	Date	GND TOW				XM901				REFIRING XM901				
			A	B	C	Q	Date	A	B	C	Q	A	B	C	Q
1	SL	26 Jan	613	888	729	2	27 Jan	731	868	872	1				
2	*G	26 Jan	654	892	771	1	27 Jan	659	856	703	1				
3	L	26 Jan	635	898	815	2									
4	*D	26 Jan	583	896	711	2									
5	SL	26 Jan	725	851	773	1	27 Jan	699	827	792	1				
6	G	26 Jan	807	878	800	1	27 Jan	736	896	835	1				
7	L	26 Jan	700	813	789	2									
8	*D	26 Jan	582	833	762	2									
9	SL	26 Jan	759	892	787	1	27 Jan	656	839	704	1				
10	G	26 Jan	775	959	861	E	27 Jan	621	821	766	2	771	878		1
11	*L	26 Jan	769	893	738	1									
12	D	26 Jan	793	973	861	E									
13	SL	26-27 Jan	760	860	695	1	27 Jan	708	864	834	1				
14	G	26-27 Jan	747	896	690	1	27 Jan	748	917	865	1				
15	*L	26-27 Jan	241	376	212	U									
16	D	26-27 Jan	630	768	596	2									
17	*SL	26 Jan	688	868	766	1	27 Jan	674	848	660	1				
18	G	26 Jan	722	875	818	1	27 Jan	729	811	891	2		846		1
19	L	26 Jan	639	786	798	2									
20	*D	26 Jan	607	702	759	U									
21	SL	26 Jan	817	937	837	E	27 Jan	752	889	785	1				
22	*G	26-27 Jan	784	883	846	1	27 Jan	702	831	686	1				
23	L	26 Jan	743	858	743	1									
24	D	26 Jan	752	920	853	E									

TABLE 12

**Performance Scores - Post Training
OT III Infantry Phase B**

Tasks 1-15 performed as squads and 16-20 performed as individuals. All tasks were retested to achieve GO.

TASK	TESTED	FAILED
1. Conduct Preoperational Checks on the AN/TAS-4	6	0
2. Install/Stow M220A1 Components on an XM901	6	0
3. Conduct Preoperational Checks on the XM901 Primary Weapons System	6	2
4. Identify Faults/Report Actions to be Taken (Troubleshoot) on the XM901 Primary Weapon System	6	1
5. Boresight a Daysight/Tracker	6	2
6. Boresight/Align the AN/TAS-4 to a Daysight/Tracker	6	3
7. Place the AN/TAS-4 into Operation	6	1
8. Manually Erect the XM901 Launcher	6	0
9. Manually Acquire and Engage a Target	6	2
10. Issue a Fire Command to an XM901 Gunner	6	1
11. Reload the Dual Launcher	6	1
12. Perform Combat (simulated) Misfire Procedures	6	2
13. Stow the XM901 Launcher	6	0
14. Evacuate the XM901	6	0
15. Dismount/Assemble the M220A1	6	0
16. Qualify With the XM901	12	0
17. Operate the Communications Equipment (AN/VIC-1 and the AN/VRC-64) on the XM901.	22	1
18. Hotloop Two XM901's (AM 1780's) With Two Forward Observers (TA-312's).	22	1
19. Connect Wire Communications (TA-312) Between a Forward Observer Position and an XM901	22	0

Table 12 (continued)

TASK	TESTED	FAILED
20. Communicate by Wire Between a Forward Observer 22 and an XM901.		0

Opinions of the test subjects about Phase B training were much less favorable than their opinions about Phase A training. For example, on the post-training questionnaire, 20 indicated Very Good and 4 indicated Good for the overall quality of Phase A training, while for Phase B training only one indicated Very Good and 13 indicated Good. The question which showed the greatest difference pertained to organization of the course. Eighteen men thought the organization of Phase A was Very Good or Good while no one thought the organization of Phase B was Very Good and only one thought it was Good.

Reasons given by the test subjects for their less favorable opinions of Phase B training are as follows:

- 1) The training schedule did not include time for maintenance, thus the crewmen were required to make up for lost time due to equipment failures out of what would normally be their free time.
- 2) The training schedule did not consider the many support activities required of the men in addition to training. The men had to start their pre-operational checkout of the ITV at 0600 and often did not finish their post-ops until after 1900. The post-ops were always done in the dark. Sometimes they would be interrupted by maintenance personnel for equipment testing. The men also shared living quarters with another group which had different hours and which did not do its share of the clean up.
- 3) The men had training on 3 nights, but received no compensatory time off during the day.
- 4) The men could not plan on free time either on week nights or week ends. They were told if they did not pass their performance tests during the week they would have to work on the week end. This was particularly disturbing to the married men who would have liked to been able to plan a trip home a week end.
- 5) In addition to ITV problems, other equipment failed without adequate spares on hand (e.g., IR sources for the target board). This caused the men to feel not enough planning had gone into the program. The lack of operational equipment resulted in the inefficient use of student time.
- 6) Consideration was not always given to the way training time was utilized. For example, loaders and drivers were required to be on the range when only squad leaders and gunners were firing on the ITV. Other activities were often not provided for the loaders and drivers.
- 7) All of the new men indicated the need for more orientation at the beginning of the program and additional instruction to help them catch up. They did not understand many of the things they were supposed to do. In some cases other crewmen helped them, but there was no organized effort on this.

- 8) Phase B was designed primarily to give refresher training to the men who had been through Phase A. Not enough attention was given to the new men. The new men were often given a brief explanation of how to do the task, then crew performance was tested before they had an opportunity to practice.
- 9) The instructors seemed to be trying to get too much done too soon. There were too many changes in procedures and in the order of events. Subjects would sometimes start one class and then be switched to another. This was done apparently because of equipment problems and also because of the need to stay on schedule.
- 10) The instructors did not give as much instruction during the second program as they did during the first, but when they did talk, they were more apt to be giving instructions or corrections while the men were performing their tasks. This made it harder to follow the instruction, and if the men were in the vehicle with the engine running, it was very hard to understand what the instructor was talking about.
- 11) The activities of the men had been disrupted for some time because of the ITV program. They were sent to Yakima for one day in November. They were then told the equipment was not ready and were sent back to Ft. Lewis. This was very disruptive because the men had made arrangements to be away and they had packed and banded all of their personal equipment. The married men living off base had also made special arrangements. The general feeling seemed to be that the men were willing to put up with the inconveniences of the program if there were legitimate reasons for them; however, they were beginning to wonder about the planning of the program.

The following comments were made by the Platoon Leader with acknowledgment that he would be identified since there is only one man in his position:

- 1) The Platoon Leader and Platoon Sergeant should receive more training on the ITV in order to know how to work with it effectively and to be able to establish new SOP's if required for the operational tests. There was no opportunity for this training. He did not even have a good opportunity to talk with the instructors because they were so busy and their training days were so long. The one exception to this was some special training he received from Captain Loo on Saturday morning after the first week of training. He does not feel this was sufficient.
- 2) He received the training schedule within the first two days; however, it did not give him all of the information he needed.
 - No time was allowed for maintenance
 - No time was allowed for movement to and from the field or from one training activity to another.
 - No equipment or support requirements were stated. It was difficult for him to plan for meals, etc.
- 3) He feels the training was too hurried and not well planned.
- 4) Insufficient attention was given to the special training needs of the

new men. This may have been due to a lack of awareness of the number of new men (8 out of 24) on the part of those responsible for training. Actually, the number of new men was changing right up to the last.

5) At the end of training he feels that he has a potential morale problem. The troops had to make up for maintenance and support activities out of their own time. The long hours and the fact they couldn't make plans has been hard on their morale. About 25% have very poor morale. This could be contagious if things don't get better.

6) He feels he should be in on the planning more than he is. He is now caught between those at the higher level who make plans without consulting him and his troops who feel he should be doing more to protect their interest.

7) He now feels that he needs (immediately after the training) at least 3 days with the platoon to develop and practice unit SOP's.

The primary problem expressed by the squad leaders was that they should know every man's duties and this was hard to accomplish in the time allowed. The new gunners had difficulty because they did not know all of the procedures associated with a particular task before they got in the turret. After they were in the turret, it was difficult for them to communicate with the instructor. The drivers had problems installing the nightsight and the collimator and in communicating with the gunner during boresighting.

On the questionnaires, significantly more men indicated a problem communicating or working together during the second training program than during the first. Interview comments indicated that the additional problems in this area during the second training program were due primarily to the unfamiliarity of the new test subjects with crew procedures and to the higher noise level within the vehicle because of the heater.

The communication problem most frequently mentioned occurred during boresighting procedures. The crewmember making adjustments where the sights are located (normally the driver) did not know which control to adjust or in which direction to comply with directions from the gunner. In most squads this continued to be a trial and error procedure until the gunner and driver finally learned to work together. The trial and error procedure continued over a longer period of time than might be expected for the following reasons:

- 1) The control adjustments were very sensitive.
- 2) It was necessary to go back and forth between azimuth and elevation adjustments.
- 3) It was a more difficult process when the boresight was way out of adjustment.

- 4) It was difficult for the men to hear each other when the engine and heater were both on.
- 5) Maintenance problems associated with the image transfer assembly and the day and night sights made the task of boresighting more variable and difficult.

There is justification for putting the meters and controls used for boresighting together in one location if boresighting will be required after every move, which may be the case.

The CVC's were used very little during both the first and second training programs. This should have been done so the men could learn and become familiar with the procedures for use of the intercom during the performance of crew tasks, and so that any problems associated with the use of this equipment could be discovered. At least two problems have been noted during the limited use of the intercom:

- 1) The loader's intercom box is in the wrong location. During loading operations his CVC cord gets in the way and gets tangled with the squad leader's CVC cord.
- 2) The gunner's intercom box should be modified to allow him to be on intercom or radio.

During the interviews most of the men commented favorably about the class on communication. According to the comments, the learning objectives and performance standards were clear and there was sufficient opportunity to practice the tasks with support, when required, from the instructor. The lesson plan given to each subject was also judged to be good or very good by most of them. Two men who commented unfavorably on the communications course said that the material was covered too quickly.

All twelve of the test subjects who were trained in the turret were asked if they noticed the lack of response (deadband) near the center position on the controller, and if they had noticed it, they were asked if it bothered them. Eight said they had noticed the deadband, 2 were bothered by it a little and 3 were bothered more than a little, but not to the point where they thought it made a big difference in their tracking. They stated that even though they tracked targets with the ITV in one direction only, it was still necessary to move the control back and forth in azimuth and elevation in order to stay on target.

Three, who indicated a problem with tracking, mentioned that they had a problem with the control actuators on one of the vehicles. Only one of the actuators worked and considerable pressure was required on the other to keep the turret motion activated.

Other tracking problems mentioned during the interview were:

- 1) The turret response was different in the different vehicles.

- 2) The hydraulic motor kicking in and out was distracting.
- 3) There was not sufficient opportunity for ITV tracking practice.

During the post training interview each Infantryman was asked if the Evasive Target Simulator (ETS) helped him to improve his Ground TOW tracking ability and if it helped him to qualify with the Ground TOW. Six said the ETS did not improve their tracking ability and that it did not help them qualify, while 18 said that the ETS did improve their tracking ability and that it did help them qualify.

During the interviews, the following reasons were given for not liking the ETS:

- 1) It is too hard to score. If you get a zero it bothers you, and you don't really know how far off you were.
- 2) The ETS does not act like a vehicle. You do not have the same feeling as when tracking the Jeep that is moving over the ground.
- 3) He could not see the target clearly because it was too small and the lighting was not good enough.
- 4) The ETS had a jerky motion in certain parts of its travel.
- 5) Lots of people kept walking around the ETS area, this threw him off.

During the interviews the following comments were given in favor of the ETS:

- 1) The close tolerance limits made him more determined and accurate in his tracking.
- 2) He learned to try harder and to concentrate.
- 3) He was not bothered by the low scores because they had not developed a standardized scoring system yet.
- 4) He was always able to keep the target within his field of view even though he didn't score very high.
- 5) Practice with the ETS must have helped because he scored expert on all 3 tasks with the Ground TOW. This is the first time he has ever done this. But the ETS had some bugs in it. It was hard to see and it had a jerky motion at certain times.
- 6) Once he got on the firing line he realized how much the ETS had helped.
- 7) The big target board was much easier after the ETS.
- 8) The ETS helped, but the blast simulators bothered him during qualifications.

- 9) Need both the ETS for readily available practice and the Jeep for the feel of tracking a real vehicle across real terrain.

The following comments were obtained in response to a question about problems with night operations:

- 1) Three squad leaders and 3 loaders indicated they had difficulty throwing the missiles out of the vehicle during Reload because of the M60 and the vertical steel plates which have been placed on top of the vehicle as part of the high stow configuration. The problem was greater at night.
- 2) One squad leader stated he could not level the TOW tripod at night because it was impossible to see the bubble.
- 3) Two gunners stated they had trouble acquiring a target at night.
- 4) Two loaders indicated they have difficulty getting a missile on the launcher guide rails at night. (A change in configuration on the guide rails and luminescent paint have been previously suggested to alleviate this problem.)
- 5) One squad leader and two gunners stated the light on the azimuth ring should cover a wider area.
- 6) All of the drivers and loaders indicated they had difficulty installing the nightsight and the collimator, and that these tasks are much harder to do at night.

During the post training interview each student was asked about those lessons which he marked on the Post Training Questionnaire as being Very Difficult, Much Too Short, or Very Poor. The interview comments are summarized below after a listing of the lessons to which the comments apply.

1. Pre-operational checks on the AN/TAS-4
2. Installation and Stowage of M220A1 Components on an XM901
3. Pre-operational checks on the primary weapon system
4. Troubleshooting the XM901 primary weapon system
5. Boresighting the Daysight/Tracker
6. Boresight alignment of the AN/TAS-4
7. Placing the AN/TAS-4 into Operation
8. Fire Command
9. Reloading the Launcher
10. Combat Misfire Procedures
11. Dismounting and Assembling the M220A1
12. Manual Erection of the XM901 Launcher
13. Manual Target Acquisition and Engagement
14. Evacuation of an XM901
15. Stowing the XM901 Launcher
16. Communications Training

Lessons 5,6, and 7 were marked Very Difficult because of the difficulty of installing the nightsight and the collimator and the difficulty of achieving boresight alignment of the day and night sights. These problems

have been discussed previously under Question 15 on communication and Question 26 on night operations.

Lesson 11 was marked Very Difficult because he had difficulty as the gunner in removing the MGS when the gunner's seat was down. He also had trouble reinstalling the MGS because there were no hand-holds in the right place.

Lesson 12 was marked Very Difficult because the men hit their hands on the steel plates while cranking and the operation required a lot of effort. The men indicated they would not want to be on top of the vehicle during combat.

Lesson 13 was marked Very Difficult because it required strenuous exertion and because the men did not think it was a feasible approach. All of the men said they would leave the vehicle during combat rather than try to perform the manual acquisition procedures. One man suggested the use of a pressure bottle with quick connect fittings.

Lesson 3 was marked Much Too Short because he felt the Pre-Operational procedures were too long. He thought a more efficient set of procedures should have been developed and that the men should have received more training on these.

Lesson 4 was marked Much Too Short because the men said they received essentially no training on troubleshooting. One man commented that the crew should have training, tools and authorization to perform simple maintenance out in the field because this could reduce down time and it would be an important asset during combat.

Lesson 13 was marked Much Too Short because he did not think the men had received sufficient training on an adequate set of procedures. He noted that the procedures were being changed during the training program.

3.2.4 Cavalry Training Performance Data

The pre and post training data are presented in Table 13.

3.2.4.1 Pre-Training Data

A pre-test of ITV firing qualification was conducted on 18 January 1978. Only the 5 men who had participated in Phase A were tested. None of them qualified.

No pre-testing of performance on the training tasks was conducted prior to Phase B training.

This Cavalry data supports similar data from the Infantry in demonstrating the importance of frequent periods of ITV tracking practice to maintain firing skills.

3.2.4.2 Post Training Data

Post training firing qualification scores were much higher at the end of Phase B than at the end of Phase A. At the end of Phase B, one qualified expert, 4 qualified 1st class and 5 qualified 2nd class, while at the end of Phase A, all of the students qualified 2nd class.

At the end of training, performance was tested on 13 tasks. Four NO GO's were given, all for Task 11: Select/Designate Targets for TOW. This is a test of Fire Commands under different conditions according to procedures presented in TC23-23. The NO GO's were retested and a GO achieved in all cases.

3.2.5 Cavalry Questionnaire Data and Observations on Phase B Training and Comparison with Similar Data on Phase A

A summary of subject observations about Phase B training is presented here. Specific comments are included only if they add information to that already presented on Phase A training.

Contrary to results from the Infantry, the Cavalry did not observe the Phase A and Phase B training programs to be significantly different.

The Cavalry were given no tracking practice or qualification firing with the Ground TOW. All of the ITV tracking practice during Phase B was accomplished with the ETS. During the Post Training Interview, every one was asked to state whether he preferred the ETS or the target board in the Jeep for tracking practice and why, and to state whether or not the deadband at the neutral point in the controller action interferred with tracking.

Six thought the ETS provided better practice than the target board for evasive targets. All of the 6 thought both target systems should be used at different times because each provided a different kind of practice. The ETS provided evasive practice and the target board in the Jeep provided practice in tracking a real vehicle over the terrain. Some thought the best practice could be obtained from tracking a target board in a Jeep which moved evasively.

The 4 subjects who did not like the ETS noted the following deficiencies:

- 1) The scoring was too sensitive resulting in scores which were too low.
- 2) The rate of motion did not seem to be calibrated accurately. The slow rate (Task A) seemed much slower than Task A with the Jeep.
- 3) The target motion was jerky at certain points.

4) While tracking the slow target during Task A it was possible to track in a straight line. While tracking the fast target during task C it was necessary to track while the target changed direction.

Seven stated that the deadband bothered them, while 3 stated they had gotten used to it and that it no longer bothered them.

Other comments which were made by a number of subjects included the following:

1) The efficiency of training was almost cut in half by the fact that the Cavalry never had more than one ITV for 2 squads.

2) Shorter people should be selected for the ITV. Tall people really have problems (there were 3 men about 6'3" in height in the Cavalry, all of whom complained about the height problem).

3) Need more on troubleshooting. During Phase A they got some hands-on-troubleshooting experience. During Phase B, each man was given a description of a problem and then asked what he would do about it. Everyone got the same problem.

4) The ITV is too crowded with 5 men. During the Pilot Test, the addition of a data collector and his instrumentation made the vehicle too crowded.

5) The ITV is not suitable as a scout vehicle. It is not rugged enough, it takes too long to move from one emplacement to another, and it does not have enough space for 5 men and their gear. A scout vehicle should be out front, while the ITV is used to better advantage if it is behind the lines or in overwatch.

3.3 OT III POST TEST TRAINING ASSESSMENT

3.3.1 Gunner Qualification Scores

Median gunner qualification scores are presented here for the successive qualification tests conducted during OT III. Each median score represents the scores on Tasks A, B, and C of all of the men who took each test. Median scores for the Ground TOW tests represent Infantrymen. Median scores for the ITV tests represent Infantry and Cavalrymen. The ranges of scores required for the different qualification levels are presented below the test scores to facilitate interpretation.

Median Qualification Scores

Initial Ground TOW	638
Post training Phase A ITV	716
Pre training Phase A Ground TOW	711
Pre training Phase B Ground TOW	711
Pre training Phase B ITV	401
Post training Phase B ITV	774
Post training Phase B Ground TOW	780
Post test ITV	729
Post test Ground TOW	792

TABLE 13

Pre and Post Training Data
OT III Cavalry Phase B

Position	Pre Test			Post Test			Tasks																	
	Date	A	B	C	Q	Date	A	B	C	Q	1	2	3	4	5	6	7	8	9	10	11	12	13	
1 TC/G	18 Jan	77	324	356	U	27 Jan	934	876	782	E														
2 AG	18 Jan	57	401	458	U	27 Jan	705	810	838	1														
3 L	18 Jan	154	31	272	U	27 Jan	639	812	789	2												X	X	
4 L	18 Jan	93	40	404	U	27 Jan	688	860	766	1														
5 DR	18 Jan	93	315	512	U	27 Jan	683	863	829	1														
6 AG*						27 Jan	616	789	744	2														
7 OBS*						27 Jan	683	815	778	1														
8 TC/G*						27 Jan	588	764	721	2														
9 DR*						27 Jan	578	753	633	2												X		
10 OBS*						27 Jan	615	827	731	2													X	

*New Personnel

TASK DESCRIPTION Note: No task had a time limit. Only procedures and knowledge were tested.

1. Characteristics and Nomenclature of the XM901.
2. Install/Perform operator maintenance on TOW day/night sight.
3. Perform MGS self test.
4. Install/remove M70 training equipment.
5. Load the XM901 launcher.
6. Operate the XM901 turret.
7. Perform before, during, and after operations maintenance checks.
8. Crew drill - XM901
9. Prepare sector sketch.
10. Apply immediate action for an XM901 failure to fire.
11. Select/designate targets for TOW.
12. Manually operate the XM901 turret.
13. Perform troubleshooting and correct malfunctions.

Qualification Level

Expert	800
1st Class	708 to 799
2nd Class	616 to 707
Unqual	0 to 616

The thing that stands out most from an examination of the qualification scores is the decided fall off in ITV scores when tracking practice is discontinued. This is seen most clearly prior to Phase B. During the 3½ months that the men were away from the ITV their qualification scores fell from a median value of 716 to 401. There was also a drop in the median ITV qualification score from 774 to 729 between the end of Phase B training and the end of the OT III program. This drop is not as dramatic as the previous one, however, the first subjects did engage in some tracking and firing during this period. Apparently the amount of ITV tracking practice received during the test program was not sufficient to maintain tracking proficiency.

The above data supports frequent observations from the men that they will need more tracking practice with the ITV than with the Ground TOW to maintain proficiency. Perhaps as the men gain more experience with the ITV there will be less need for continued practice. However, the initial Ground TOW median score indicated the men were not getting enough practice at their home post to maintain proficiency on the Ground TOW. Thus, it is safe to say the troops need more refresher training with the Ground TOW than they are currently getting at their home base and they will probably need even more than this to maintain ITV tracking skills and to maintain proficiency on the more complex crew tasks associated with the ITV.

Another point that can be gained from on observation of the median qualification scores is that there is very little difference between the scores for the Ground TOW and for the ITV after training. The differences between the Ground TOW and ITV scores after Phase A training and after Phase B training are not large enough to be statistically significant.

3.3.2 Post Test Training Questionnaire

At the completion of OT III a training assessment questionnaire was administered to all Infantry and Cavalry personnel. The purpose of the questionnaire was to determine those areas where additional pre-test training would have benefited personnel during conduct of the test.

Questions were included to determine how much more or how much less verbal explanation and practice the men thought they needed for the performance of specific tasks during the test program and during combat.

The questionnaire is included in the Appendix A, ARI ITV Report. The tasks are presented here which had a mean response value of 3.4 or more or 2.6 or less on the following scale:

For OT III (or Combat on separate question), I needed:

- 1 = much less than I received during training
- 2 = less
- 3 = right amount
- 4 = more
- 5 = much more

The scale was applied to Verbal Explanation and to Practice for each task. A mean response of 3.4 or more or 2.6 or less meant that approximately half or more of the test subjects thought they needed more (or less) verbal explanation or practice on a particular task.

For the OT III program, the Infantry squad leaders and gunners wanted more training on the following tasks:

- | | |
|--|--------------------------------------|
| 1) Fire command, or passing target information from squad leader to gunner | more practice |
| 2) Accepting target information from outside observers or units | more verbal explanation and practice |
| 3) Target hand-off procedures between ITV's | more verbal explanation |
| 4) ITV tracking on an incline | more practice |
| 5) Use of the M60 machine gun | more verbal explanation and practice |
| 6) Tactical procedures with the ITV | more verbal explanation and practice |

There were 15 tasks listed for Infantry squad leaders and gunners from which 8 were identified as requiring more training for the test program and for combat. There were 22 tasks listed for all Infantry crew members from which 4 were identified as requiring more training and 4 were identified as requiring less training for the test program and combat.

Boresighting was identified as a task which required less training even though it had been identified as a problem area immediately after training. Apparently the problems with boresighting were considered to be due to poor human factors design rather than to the lack of proper training.

Another point worth noting is that on the questionnaire as a whole there was a greater need indicated for more practice than for more verbal explanation. This conforms with numerous student observations that hands-on training is best and what they needed most was more opportunity to practice.

The following responses were given to separate questions:

- 1) The median response of squad leaders and gunners indicates they think they should practice ITV tracking 1 hour every week to maintain proficiency.
- 2) The median response of all crew members indicates they should practice Ground TOW tracking 1 hour every two weeks to maintain proficiency.
- 3) The median response of all crew members indicates they should practice crew drills $\frac{1}{2}$ day every 3 weeks to maintain proficiency.
- 4) All six of the squad leaders believe they should have received training on maintenance of the ITV similar to organizational maintenance training.

3.4 DT III TRAINING DATA AND OBSERVATIONS

3.4.1 Training Performance Data

No actual testing of familiarization training took place. AMSAA test plans called for an intricate matrix of GO tracking tasks to be completed by each gunner. Order of tasks varied between individual test subjects. It was found that ITV qualification scores at DT III were lower than those at OT III.

TABLE 14

DT III and OT III (Prior TOW Experience) ITV Mean Qualification Scores

	5 MR/SEC	15 MR/SEC	25 MR/SEC
DT III \bar{X} (n=21)	438	754	682
OT III \bar{X} (n=6)	640	824	702

Part of the score differences can be accounted for by equipment differences. The vehicles at WSMR, the DT III site, had very noticeable deadband in the azimuth controls. An examination of qualification scores of DT III test subjects who had prior TOW experience ($n=21$) and those who did not ($n=10$) shows significant differences. This indicates that gunners with TOW experience will probably qualify with higher scores than those without experience. This indicates a degree of positive training transfer between the systems.

TABLE 15

PRIOR TOW EXPERIENCE, DT III

	5MR/SEC	15 MR/SEC	25 MR/SEC
Prior TOW	438	754	682
No Prior TOW	341	699	568

Significant difference at .01 level

3.4.2 Responses to the Post Training Questionnaire

The Post Training Questionnaire was administered to 30 test subject personnel on 12 September 1977.

The questions are presented in the Appendix A, ARI ITV Report together with a tabulation of player personnel responses after each question. The responses are not categorized according to crew position because the men received cross-training in all positions.

Responses to the questionnaire are summarized below:

The overall quality of training was considered Good by a majority of the subjects (17).

The overall amount of training was considered to be the Right Amount by 16 and Too Short by 14.

The training workload was considered Satisfactory by 19 and Too Easy by 10.

The learning objectives and performance requirements were considered clear by a majority of the subjects, however, there were also a large number of responses indicating Borderline.

The written material was considered Good by half while the other half had mixed opinions.

Opinions about the organization of the course were divided: 11 thought it was Good, 12 Borderline, 6 Poor and 1 Very Poor.

Opinions about the use of training aids were divided: 14 thought it was Borderline, 10 Good or Very Good and 6 Poor.

Teaching by the instructors was considered Good by a majority (19).

Twelve of the 30 men were bothered by distractions during the training program. Comments indicated these were due to equipment failures, disorganization, range closures for missile firings, noise from the 113 engine while the instructor was talking and to student groups that were too large.

The majority of test subjects (25) thought the size of the groups was right for training. (Apparently, the size of the group was increased at times, when one piece of equipment was being repaired, and this caused unfavorable comments).

One third of the subjects (10) had problems in learning to track with the ITV. The following problems were listed:

Hand controls were hard to get used to
Different ITV's had different control responses
There was a delay in the response to control movement
The turret had a jumpy feel. You never knew when it was going to take off on you.
The evasive target source was hard to follow
Tracked from a tilt position to early in the practice runs
Need more hands-on time to adjust to turret

Five thought the transfer of training from Ground TOW tracking to ITV tracking was negative, 9 thought it was positive and 13 indicated no effect.

Nine thought there was negative transfer from ITV tracking to Ground TOW tracking, 6 students thought the transfer was positive and 13 indicated no effect.

Opinion was evenly divided about which equipment it was easiest to learn to track with. They thought it was easier to learn with the ITV, 12 thought it was easier with the Ground TOW and 6 indicated Borderline.

The majority (18) thought the ITV was better for tracking a slow moving target while 9 thought the Ground TOW was better.

Opinion was evenly divided about which was better for tracking a fast moving target. Fourteen voted in favor of the ITV and 13 in favor of the Ground TOW.

The majority of test subjects thought they got enough tracking practice with both the ITV and the Ground TOW.

Almost every one tracked with ITVETS (evasive target simulator) thought it was more difficult than the regular M-70 target on the Jeep.

Questions 25 through 32 on the Post-Training Questionnaire are not considered because they do not apply to the DT III training program at White Sands.

3.4.3 Responses to the Post Training Interview

Interview No. 1 was conducted at White Sands, on 21 September 1977, after the responses to the Post Training Questionnaire had been obtained. The interview included many of the same questions which were on the questionnaire, however, the format was different. Eight major topic areas were discussed with each student who was interviewed. An attempt was made to get test subjects to comment on all aspects of each topic area. The actual questions were determined to a considerable extent by the nature of each interview.

Representative comments during the interviews are presented under the eight major topic headings plus one category of general comments.

Amount and Quality of Training:

Training by Ft. Benning instructors was good, but too short and too rushed - difficult for him to remember it.

Instructors were very informal and sensitive to the test subjects, which was good, but they needed more time on each subject area.

Better orientation at the beginning of the program would improve the efficiency of the training program, e.g., films on Ground TOW during previous training were good.

Needed more equipment and it should have been in better working order. Men stood around too much, not utilized effectively. Needed more hands-on training.

Got enough training to be able to use the ITV, but would need much more for combat.

Need practice on crew drills, learned about them, but received no practice.

More orientation to program would help, however, men can get only so much out of lectures and reading before hands-on training. More hands-on is needed. Can't do anything right until you get used to it.

The men had to learn a lot on their own, e.g., instructors did not have time to go over brake system on turret. The brakes are used to eliminate drift of launcher while in a cant angle - this was not explained.

Amount and Quality of Written Material:

Got some books, but not sure if they are on ITV. There was a book on tank identification and one on the Ground TOW. Hasn't looked at them very much.

Looked through all of the written material. It is good and no changes are required. He did not look at written material too close because he did not want to get ahead of the other students.

He only looked at book on tank identification. When he gets back to Ft. Bragg he won't be using the ITV, but he will have to know tank identification. He would study the hell out of written material if he knew he would be with the ITV.

He looked at written material, it looked O.K. It was up to the individual to read it, he was not urged to read it nor was he tested on it.

In the beginning you can't comprehend from written material without hands-on experience. Need more hands-on.

A brief outline of the course and the important things to remember should have been given to the students at the beginning.

Skimmed written material when he first got it. Not sure about the need for improvement in this material because he didn't read it deeply enough. The equipment was so easy he did not need to read about it. Main benefit of written material would be for crew duties, which they didn't do. The things they did didn't require written material.

They were not required to read the written material. A course outline reading assignments should have been given out.

Distractions During Training Program

During the first week of training there were only two ITV's and one was down part of the time. For this reason the size of the groups on the ITV's was too large, and it was difficult for those to back to hear.

The engines were running all of the time during M-70 tracking, which made it difficult for the gunner to hear corrections. The engines were not running during the hit probability runs so they were not comparable to the M-70 in this respect.

The sun and the heat made it difficult to concentrate.

The range was shut-down frequently because of missile firings. This caused a loss of time and a loss in the train of thought for what we were doing.

The size of each group was too large for sufficient hands-on experience.

Problems in Learning to Track

The control handles for tracking were awkward. They were oriented too far forward, which made it difficult to achieve good pitch control. This was changed on the latest ITV sent to White Sands - it was better.

The handles were too high. He had to put the seat all the way down to view through the sight. The seat adjustment was O.K., but the handles were high when the seat was low.

There were a number of differences in tracking characteristics between the different ITV's. Differences in characteristics described by different individuals include the following:

- Differences in control sensitivity between ITV's
- Differences in amount of turret drift when the controls were centered
- Differences in amount of dead space at the center point of the controller
- Differences in the amount of action when the controller is moved past the center dead space and begins to activate turret movement.

Dead space at the center point of controller movement made it significantly more difficult to track an evasive target. (On one ITV, which was examined by ARI representatives, this dead space, in which no response occurred, covered a range of approximately 15° across the center point in azimuth).

The amount of response in turret movement which occurred when the controller was moved past the dead space was determined, in part, by the rate of controller movement. Too much controller action across the null point would cause the turret to jump. Too little controller action across the null point would cause the turret to fall behind the target.

One individual mentioned some of the problems already presented, but thought good control could be achieved after sufficient practice.

The hydraulic motor cutting in and out interfered with tracking during the early stages of learning. Most of the men said they got used to it and that it did not bother them later on.

Transfer of Training Between Ground TOW and ITV

Several indicated positive transfer was obtained from Ground TOW experience to ITV because of the many similarities. The visual scene is the same and the missile characteristics are the same. One man observed that those without previous TOW experience were not sufficiently aware of the importance of the last part of the tracking run.

Some felt that Ground TOW experience had a negative effect on ITV tracking during early exposure to the ITV primarily because of a tendency to exert too much pressure on the ITV controls. After a day or two they thought that TOW experience helped because of the many similarities in the tracking situation.

One stated that previous Ground TOW experience didn't help in ITV training. All did about as well with and without previous experience. The techniques were so different between the Ground TOW and the ITV that there was neither negative nor positive transfer.

Another tracked better on the Ground TOW because of tracking practice on the ITV. He noted that all his people improved on the ground mount after ITV training and practice.

Can learn to adjust fairly quickly and overcome negative effects on going back and forth between Ground TOW and ITV.

Preference For Tracking With Ground TOW vs. ITV

He could do better with the Ground TOW when tracking evasive targets. Evasive targets were difficult to track with the ITV because the turret jumped as he crossed the null point of the controller. He felt that he could track straight target motions, both slow and fast, better with the ITV because the velocity aiding helped him stay on target.

He tracked better with Ground TOW in all cases because of more experience. Ground TOW is more sensitive - you have direct eye-hand coordination. To get good scores with the ITV you would need to track several hours per day for 2 or 3 weeks.

Would rather be with Ground TOW and jeep - more mobility and easier to camouflage. ITV is better for tracking during poor environment conditions, such as wind.

Comparison of M-70 and ITVETS

He liked the M-70 much better than the ETS because he had a better feel for it. ETS should provide better practice for combat against evasive tanks, but he got mad at ETS. He couldn't stay on ETS, but knew he could stay on a tank. He had no problem during hit probability runs except that he wasn't sure where to aim and his score suffered. However, he was on the tank the whole time and would have killed it.

When tracking with ETS it was easy to lose the target when it changed direction at the high speed.

During the evasive maneuvers of ETS the target jerked as it went from left to right, but not form right to left.

Change of direction caused most of the trouble with the ETS - across the null point of the ITV controller.

M-70 Jeep is better training for tank tracking because the Jeep is going over ground just like the tank is. There are bumps and other things associated with the ground that don't occur with ETS. ETS is smooth.

Evasive maneuvers of the ETS do help in learning to track the evasive maneuvers of the tanks, but you don't get the feeling of tracking a real vehicle. They should use a maneuvering Jeep to train for evasive maneuvers. This was done at the home base by swivelling the target as the jeep changed direction and it worked very well.

Night Tracking

It was difficult to distinguish distant targets at night. Once he was familiar with what the target looked like through the night sight he was able to pick it up. However, there was only one thing out there that looked like the target. If there had been many similar objects at a long distance away he would not have been able to distinguish them. Would need a lot of training with specific targets to be able to distinguish them.

Two night sights worked well and were very clear, the other two night sights were not as clear when looking at distant targets. Had to know what was out there to know what it was at a distance.

General Comments

The missile simulators were not balanced for the Ground TOW - not the same as an actual missile.

The instructors were good, but there were too few of them and they left too soon.

Learned about the crew drills, but did not practice them - would need refresher training to do the crew drills now.

The tracking conditions were different during the qualification runs, and, therefore, they cannot be compared. The 3rd qualification run for the Ground TOW was done some distance from the normal training base, and the road for the target Jeep was much smoother than the target road at the base. In addition, the weather varied considerably. Sometimes it was very hot and sometimes it was very dusty. The wind was very strong and gusty during Task B of the 4th qualification run on the Ground TOW (9/21/77) when it was also gusty, but not as bad as the previous day.

4. SUMMARY OF RESULTS

The results of this independent evaluation of training are summarized in terms of responses to the key training issues which were listed at the beginning of this report in Section 2.1. The results are primarily from the OT III training program. DT III training results are included when they contribute to a particular training issue.

1) Is the ITV training program adequate for new equipment training?

a) Instruction

The instruction during Phase A was considered very good by both the Infantry and the Cavalry and by the independent observers responsible for this report. The Infantry instruction during Phase B was considered adequate, but it was not rated as good by the test subjects during Phase A, even though most of the instructors were the same. The primary reason for the lower appraisal of the instruction appeared to be the lack of planning for the new crewmen, the number of which were unanticipated by the instructors (1/3 of the Infantry students and ½ of the Cavalry students were new at the beginning of Phase B). The Infantry program was probably affected more by new personnel than the Cavalry program because it included more crew tasks and many of the tasks were timed while those of the Cavalry were not. Lack of organization and lack of consideration for the needs of the subjects also contributed to the lower appraisal of the Infantry program at the end of Phase B.

b) Methods of training

Most aspects of the training were evaluated as very good by both the Infantry and Cavalry and by the independent observers responsible for this report. These aspects include the basic hands-on nature of the training, the clarity of learning objectives and performance requirements, the organization of the course during Phase A and the training workload. Deficiencies which were noted include the following:

- 1) lack of sufficient orientation
- 2) too much specific information given early in the program
- 3) not enough control over the test subjects
- 4) need for testing during the course of the Infantry program to motivate and provide feedback
- 5) need for a lesson schedule which summarizes the material to be covered during each lesson and which includes reading assignments when required. (note: this need was satisfied during Phase B of the Infantry program, but remains a requirement for the Cavalry program - i.e., the Cavalry students did not receive an abbreviated lesson plan although the instructors had a detailed plan)

c) Training aids

The most representative comment that come from a number of men was that the ITV is the best training aid and there should have been one ITV per squad. Certainly the efficiency of training would have been improved considerably had more ITV's been available. There were also a number of comments that slides and/or a movie would have been of value for orientation early in the program.

d) Training literature

A large majority of the men indicated the training literature was good or very good. However, during the post training interview it became evident that most of the men made very little use of the written material. One reason for the lack of use was that the instructors apparently neither required nor urged the men to use it. Several comments indicated that lesson plans which included brief summaries of the important things to be learned would have aided both student preparation and review. They would be of particular help to crewmen who do not refer to the manuals because of reading problems.

e) Performance of test subjects at the end of training

Minimum qualification requirements on Firing Table VII were exceeded on the ITV by all Infantry squad leaders and gunners and by all Cavalry crewmen and on the Ground TOW by all Infantry crewmen with the exception of one loader and one driver. At the end of Phase A, the numbers of Infantry squad leaders and gunners qualifying 1st and 2nd class upon first try with the ITV were 7 and 5, compared with 10 and 2 at the end of Phase B. When given a second chance at the end of Phase A they all qualified 1st class. All of the Cavalry qualified 2nd class on the ITV at the end of Phase A, while one qualified expert, 4 qualified 1st class and 5 qualified 2nd class at the end of Phase B. The numbers of Infantry crewmen qualifying 1st, 2nd and unqualified on the Ground TOW were 8, 15 and 1 compared with 11, 7 and 2 plus 4 experts at the end of Phase B.

All of the training performance tasks were passed by all of the Infantry and Cavalry crews. However, additional training was required before some of the tasks were passed the second time they were tested. Task performance of the Infantry crews at the end of Phase B was not as good as at the end of Phase A. When first tested, 15% of the tasks were NO GO at the end of Phase A, while 26% were NO GO at the end of Phase B. All of the NO GO's were changed to GO upon retest, including at the end of Phase B, the reload task which has a very stringent time requirement of 45 seconds. The poorer performance of the Infantry crews at the end of Phase B is probably due to the

unanticipated large number of new students in Phase B and the problems of integrating them into the existing crews without an advance plan to do this. Task performance of the Cavalry crews was slightly better at the end of Phase B than at the end of Phase A. There were 15% NO GO's at the end of Phase B all of which were changed to GO upon retest. The Cavalry tasks were not timed which made it easier to pass the performance tests.

- f) Performance of test subjects during the test program
Performance of the men met the requirements of the test program with the possible exception that the Cavalry crews were slow during the early acquisition trials because their training tasks had not been timed. However, after the first few days of testing their performance was comparable to that of the Infantry.
- 2) What is the length of time required to train an ITV crew with and without Ground TOW experience?
Is this time significantly greater than that for Ground TOW training?

The Infantry Phase A program provides an indication of the length of time required to train an ITV crew with Ground TOW experience. The Infantry devoted 36 hours to ITV training. This was accomplished with 3 ITV's for 6 squads which were operational about 50% of the time. The effect of the shortage of ITV's was alleviated by concurrently administering remedial training on the Ground TOW. Even with this relief, each squad had an ITV available only about 50% of the time during the 36 hours it was assigned to ITV training. Immediately after the training the troops passed firing qualification and crew performance test requirements, with some retesting required to meet these requirements. However, there was limited opportunity for cross training, for which the squad leader had special need to perform his leadership role, and there was not sufficient opportunity to practice with the equipment to promote retention and adequate performance under stress.

The efficiency of training and effective utilization of troop time would be increased if ITV training were carried out in one block of instruction during which one ITV would be available for each squad. Under these conditions it is estimated that basic ITV institutional training could be adequately accomplished in four 8-hour days with troops which have Ground TOW experience. One additional day would be required for testing. This 32 hours of ITV training time represents an increase of 47% over the 21.5 hours of training time now devoted to Ground TOW training by the Infantry School.

Much of the training required for these topics would normally occur within the parent unit or in a special training course. However, it is suggested that, immediately after basic ITV training, 3 days of operational training can be justified to add meaning to the basic instruction and promote greater retention. Thus, a total of 10 days is suggested for ITV training for experienced TOW troops which would consist of the following:

1) Remedial TOW training	16 hrs	(2 days)
2) Basic ITV training	32 hrs	(4 days)
3) Tests of crew performance and firing qualification	8 hrs	(1 day)
4) Tactics training and operational experience	24 hrs	<u>(3 days)</u>
		10 days

Prior to OT III testing the troops engaged in a Pilot Test and in FTX maneuvers. The operational use of the ITV during these activities helped to prepare the troops for the test program. Immediately prior to the tests, the Assistant Director in Charge of Training certified that the troops were ready.

The Cavalry Phase A program provides an indication of the length of time required to train an ITV crew without previous Ground TOW experience. The Cavalry troops devoted 38 hours to ITV training during which they passed the required performance tests and after which they all qualified second class. An ITV was available to each squad during less than half of the 38 hours of training time. The amount of time the ITV was available during training was about the same for the Infantry and the Cavalry. The Cavalry achieved more cross training than the Infantry, but the troops qualified at a lower level on Firing Table VII and their performance tests were not timed. For the Cavalry to match the performance standards of the Infantry, at least another day of training would be required with an ITV available for each squad. After an additional day of training, the level of firing qualification for the Cavalry would probably still not be as high as for the Infantry because Infantry squad leaders and gunners have been selected partly on the basis of tracking capability.

- 3) What are the effects of transfer of training between the Ground TOW and the ITV?

Can a gunner maintain tracking proficiency on both the Ground TOW and the ITV?

Twenty four hours of remedial TOW training were given during the 7-day period in which ITV training occurred. Comments from the troops indicate this was more than necessary. Experienced TOW troops will probably need some remedial TOW training, depending upon their current proficiency, but 2 days of this should represent a maximum. A limited number of drivers or loaders may not qualify on Firing Table VII after 2 days of remedial training (1 failed to qualify during Phase A): however, additional training time for all of the troops does not appear to be justified to achieve 100% qualification.

After Phase A of the basic ITV training program, 3 days of training were given on tactics and on the operational use of the ITV. Although this training was rated favorably by the troops, it was not sufficient to satisfy their perceived requirements, either for the test program or for combat. On the Post Test Questionnaire, the players indicated the need for more training on the following tasks to enable them to perform adequately in the test program:

- 1) Passing target information to the gunner from the squad leader or from outside observers or units
- 2) ITV tracking on an incline
- 3) Use of M60 machine gun
- 4) Tactical procedures with the ITV
- 5) Use of backup signals when the communication system is not working
- 6) Standard Operating Procedures (SOP's) for specific situations
- 7) Lack of sufficient cross training to enable the squad leaders to fulfill their leadership role was not included in the questionnaire but was commented upon several times during the training.

For combat, the test subjects indicated a need for more training on the following:

- 8) Map reading
- 9) Range determination
- 10) Camouflage techniques
- 11) Vehicle identification

During OT III training conditions were not systematically varied to provide a controlled test of the effects of transfer of training. However, the men did switch back and forth between the Ground TOW and the ITV during the course of the training program. The tracking data show that the men improved on both systems during the training period. Any effects of negative transfer that may have occurred were overshadowed by positive transfer and by practice effects. On the Post Training Questionnaire, at the end of Phase A, a large majority of the squad leaders and gunners indicated there was no transfer effect or there was positive transfer in going from one system of tracking to the other. During the interview the few who thought the Ground TOW experience had negative effects stated that these effects disappeared during the early stages of ITV training. Several men stated there were no transfer effects because the equipment is so different. Those who thought there was positive transfer usually mentioned the similarities in the tracking situation, such as the target motion and the missile tracking characteristics represented by the M70. Most of the gunners indicated they would have no trouble going back and forth between the Ground TOW and the ITV if they could continue to practice enough to maintain proficiency on both.

- 4) What is the long term retention of ITV tracking skills as measured periodically during the test program after training?

In Section 3.3.1 median gunner qualification scores are presented for the successive qualification tests conducted during OT III. At the end of Phase A training, the median qualification scores with the Ground TOW and the ITV were 711 and 716 respectively. A statistical analysis shows that these scores were not significantly different from each other. Prior to Phase B, 3½ months later, the median qualification score with the Ground TOW was found to be the same as it was after Phase A, while the median score with the ITV had dropped significantly to 401. At the end of Phase B training, the median scores with the Ground TOW and the ITV (780 and 774) were again found not to be significantly different, while at the end of the test program, 2 months later, the median score with the Ground TOW had increased slightly to 792 and the median score with the ITV had decreased significantly to 729.

The above data supports frequent observations from the men that they will need more tracking practice with the ITV than with the Ground TOW to maintain proficiency. Perhaps as the men gain more experience with the ITV there will be less need for continued practice. A low initial median score of 638 with the Ground TOW prior to training indicates the men were not getting sufficient practice at their home base to maintain proficiency. Thus, the tracking data obtained during this program indicate that the troops need more training at their home base than they are currently getting to maintain tracking proficiency with the Ground TOW and they will need even more than this to maintain proficiency with the ITV.

- 5) How adequate is the M70 training system with the Jeep mounted target and how adequate is the Evasive Target Simulator (ETS) for training gunners to hit real targets which move evasively? How do these two training systems compare?

During Phase A of OT III the only training system used by the Infantry was the M70 Jeep mounted target board. During Phase B, all Infantry crewmen trained with the ETS while tracking with the Ground TOW, and the squad leaders and gunners trained with the M70 Jeep while tracking with the ITV. During Phase A, 33% of the crewmen qualified 1st class with the Ground TOW using the M70, while during Phase B 55% qualified 1st class with the Ground TOW training with the ETS and qualifying using the M70. The increase of those qualifying 1st class from Phase A to Phase B was 66%. During Phase A, 58% of the squad leaders and gunners qualified 1st class on first try with the ITV and M70 Jeep, while during Phase B 83% qualified 1st class with the ITV and M70 Jeep. The increase of those qualifying 1st class from Phase A to Phase B was 43%. Thus, there was a greater improvement in tracking ability associated with the ETS than with the M70 Jeep. Because of the small numbers, the difference in improvement is not statistically significant. However, the training data provide strong support for the ETS, particularly since the final qualification test in all cases was with the M70 Jeep.

The Cavalry trained with the ITV and M70 Jeep during Phase A and with the ITV and ETS during Phase B. At the end of Phase A they all qualified 2nd class, while at the end of Phase B one qualified expert, four 1st class, and five 2nd class. This improvement in performance after ETS training demonstrates that ETS training can transfer to other target systems because, as with the Infantry, final testing was accomplished with the M70 Jeep. One of the Cavalry men who qualified 1st class with the M70 Jeep had trained only with the ETS.

Live fire performance was evaluated against Manned Evasive Target Tanks (METT's) which maneuvered an equal number of times over an evasive course and a rapid advance course. With a reliable ITV system, 46 hits were obtained out of 54 shots by the Infantry and the Cavalry for a performance effectiveness of 85%. Two of these shots were made with loose dust which completely occluded the target and one shot was inadvertently made with the wide field of view. If these three shots are dropped from consideration, the performance effectiveness was 90%.

Since the Infantry trained on the ITV with the M70 Jeep while the Cavalry trained on the ITV with ETS, it is tempting to compare the two training systems in terms of the live fire performance of the Infantry and the Cavalry. However, such a comparison would not be valid because of other differences between the Infantry and the Cavalry and because of the small number of live fire shots. For

information, the Infantry had 43 reliable shots with 39 hits for a performance effectiveness of 90%, while the Cavalry had 8 reliable shots with 7 hits for a performance of 88%. The data cannot be used for comparison, but they indicate that both systems provide training that will transfer to the operational task.

During the post training interview each of the test subjects was asked if the ETS helped him to improve his tracking ability. Eighteen Infantry men and 6 Cavalry men said that it did improve their tracking ability, while 6 Infantry and 4 Cavalry subjects said that it did not help to improve their tracking ability. The primary comment given in favor of the ETS was that the close tolerance limits forced the men to try harder and improved their ability to concentrate. Comments given against the ETS referred to the difficulty of getting a high score, the fact that it did not act like a vehicle and the inaccuracy of the calibration for rate of motion. The majority thought both the M70 Jeep and the ETS should be used to provide different kinds of training. The M70 Jeep provides practice in tracking a real vehicle, while the ETS can provide readily available practice on an evasive target.

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